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THE VOICE TEST OF HEARING*

DOUGLAS MACFARLAN, M.D.

PHILADELPHIA

In the use of the voice for testing hearing, the method of varied range has been adopted universally. Roughly described, the examiner approaches the subject and speaks or whispers words, numbers, sentences or questions that are supposed to be repeated or answered. A record is made of the distance at which the voice is heard, and the patient is graded in comparison to normal. The procedure seems simple, and superficially it appears that the test should be accurate. On careful examination, however, a large number of variable factors present themselves. It is not merely sufficient to enumerate these variables in order to eliminate them; they must be fully understood to be controlled properly. Some cannot be done away with entirely and have to be reduced to their minimum effect.

In studying the voice test, one deals with two great fields, namely, the field of stimulation and the field of perception.

The field of stimulation leads to a study of the hearing-stimulus used, namely, the voice. The voice is sound generated by the vocal cords where the tone originates and where its pitch is controlled. The amplitude is supplied by the air blast and the quality by the resonators. The range of pitch in the human voice is between 300 and 3,000 double vibrations a second. Speech is composed of vowels and consonants which are combined and perceived as complexes of sound. The vowels are musical, that is, "speech sounds that can be continuously intoned, separated from the combinations and noises by which they are made into words." The consonants are noises, labials, gutturals, explosives and nasals. Yet certain consonants may be carried as tones, such as l, m, n and r. Words are characterized chiefly by their vowel sounds, and herein lies the greatest complication of the test.

The voice and speech are the objective side of the voice test (their more minute physical characteristics will be considered fully later). The subjective side is the appreciation or perception of speech by hearing.

* From the Graduate School of Medicine, University of Pennsylvania.

E.B 1-7-27

THE FIELD OF PERCEPTION

The Mental Sphere of Hearing.—"The ability to perceive or to interpret one's perceptions varies greatly in the individual." [1] No two subjects will respond alike to the speech tests. Explanation of this is found in considering the hearing function as confined not alone to the auditory mechanism and its pathways, but with equal importance dependent on higher mental processes. Normal persons differ less in their simple sensory perceptions than in their interpretations. For, physiologically, the higher nerve centers and their associations are the most complex and subtle mechanisms of the body. The conscious and subconscious mental spheres throw variables that are practically imponderable into the voice test observations. Thus the valuation is affected by such influence as general intelligence, alertness, attention, distraction, fatigue and training.

The Emotional Spheres.—These spheres also enter as variables, namely, eagerness, fear of making a mistake, confusion, complacency and bashfulness; all these are factors that influence the character and promptness of the response.

These facts are illustrated in the education of partially deaf children. An apparently marked improvement takes place when these children are placed on a training system. They seem to hear better, but actually the simpler sensory phenomena of hearing do not change; improvement takes place in the ability of the subject to interpret more quickly and more accurately the imperfect sounds that are heard. The methods in this training are well known among the teachers of the deaf.[2] They are found fully presented in a paper by John Dutton Wright, entitled "Enhancing Auditory Acuity by Psychologic Methods."

Demonstration of Central Perception.—Veraguth, Albrecht [3] and Goebel [4] have demonstrated that there is an independent and central type of deafness in which the external acoustic apparatus and auditory nerve may function and yet perception be absent. This discovery was made by the observation of psychogalvanic changes when a centrally deaf patient was subjected to hearing stimuli, the patient being put in

1. Kern, Maximillian: Am. J. Clin. Med. **30:** (Aug.) 1923.

2. With the totally deaf there is no possibility of "sharpening" hearing perception—there is no hearing. Any comprehension of speech in these subjects takes place entirely by the department of senses apart from, yet substituting for, the auditory function.

3. Albrecht: Die Trennung der nichtorganischen von der organischen Hörstörung mit Hilfe des psycho-galvanischen Reflexes, Arch. f. Ohrenh. **101:1**, 1918.

4. Goebel, O.: Zur Wertung des psycho-galvanischen Reflexes, Arch. f. Ohrenh. **102:**183-185, 1918.

circuit with a low tension current. The galvanometer in the circuit recorded reactions, but the patient perceived nothing (fatigue [5]).

Barth [6] describes a simple method of detecting central deafness: If a deaf person sings a familiar song with musical correctness, there is probably some degree of psychogenic deafness. This is substantiated if he will sing the same song correctly in a key differing from that used in a piano accompaniment. This test presupposes that the patient is not without some ear for music.

There are certain cases of simulated deafness or deaf-mutism the cause of which is wholly a fault in the sphere of attention. The following case is illustrative.

A bright and alert colored child, aged 7, appeared to be a deaf-mute. He did not respond to the spoken voice, to the forks, the Galton whistle, the monochord nor to the electric audiometer. When strong auditory stimuli were given, there was no trace of perception in any change of facial expression, movement of the eyes or the lids. Nevertheless the child showed strong powers of mimicry of motions, and apparently attempted to speak when lip, tongue and mouth movement were made in front of him. His speech instructor articulated vowel sounds at his ears, and the boy would make a fair reproduction of the sound in reply. With brow to the child's brow, the teacher could transmit sound to the child by bone conduction, for he was able to answer the tone. Yet there was not the slightest response to the usual auditory tests.

Sir Morrell MacKenzie [7] and Collins have both mentioned this type of case in their writings on aphonia and aphasia. Subjects with hysteria show this attention-suspension characteristic as do those persons of the "pincushion" type who can negative their consciousness of tactile and pain sensation.

INTERPRETATION OF SPEECH

The most thorough investigation of the probability of error in the interpretation of speech (English language) has been made by Harvey Fletcher.[8]

A method was developed for measuring quantitatively the ability of the ear to interpret the transmitted speech sounds under different conditions of distortion and loudness. By choosing these conditions properly, considerable information was gained concerning both speech and hearing. . . . Briefly stated, the method consists in pronouncing detached speech sounds into the transmitting end of a telephonic system, and having observers write the sounds which they hear at the

5. Brunrlow, O., and Lowensteen, O.: Ueber eine Bestimmung der wahren Hörfahigkeit und die Unterscheidung der organischen von der psychogenen Schwerhörigkeit und Taubheit, Ztschr. f. Ohrenh. **81**:145-147, 1921. (Observations of unconscious movements of expression; eye, respiratory and abdominal movements arising from auditory stimulations, especially those stimulations exciting higher mental spheres.)

6. Barth: Zur Differentialdiagnose organischer und psychogener Störungen, Deutsche med. Wchnschr. **36**:993, 1918.

7. Mackenzie, Sir Morrell: Textbook on Aphonia.

8. Fletcher, Harvey: The Nature of Speech and Its Interpretation, J. Franklin Inst., June, 1922.

receiving end. The comparison of the called sounds with those observed shows the number and kind of errors which are made. The per cent of the total sounds spoken which are correctly received is called the Articulation of the System.

In order to pronounce these speech sounds properly, they must be combined into syllables. For the purpose of this investigation they were combined into monosyllables of the simple types—consonant-vowel, vowel-consonant and consonant-vowel-consonant.

To eliminate memory effects, every possible combination of the sounds into these types of syllables was used unless there was a good reason for excluding it. The complete list contained 8,700 syllables. For convenience of testing, these syllables were divided into groups of fifty. Each group contained the same kind and number of syllable-forms and an equal number of each fundamental vowel and consonant words.

I have quoted the description of the test rather fully to show the thoroughness of the work.

A large number of individual record sheets were tabulated in an analysis sheet, by which means the factor of error and the nature and frequency of each error was obtained. For example, *p* was recorded as *k* 24.4 per cent, as *p* 45 per cent and as *t* 22.2 per cent of the times called. "On the other hand, *w* was only recorded incorrectly 1 per cent of the times called. For this system the consonant articulation (percentage of correct answers) was 65.8 and vowel articulation 84.3."

The ratio of correct to incorrect answers seems low; in other words, there seems to be a large factor of error. But it must be understood that in spite of the fact that these tests were made on subjects with normal hearing and with clearly audible voice sounds, the test words used were for the most part not actual words but manufactured meaningless combinations of syllables. It may be observed in one of the individual test sheets that Fletcher uses as an illustration that when the test sounds were actual words or sounds nearly resembling actual words, the errors were much less frequent. Further, from the observations of Dayton C. Miller [9] it must be conceded that the individuality of various telephonic diaphragms have distinct distortion effects on certain voice sounds. These facts, however, do not invalidate Fletcher's valuable contributions to the knowledge of the perception of speech, to which further reference is made later.

INTELLIGENCE AND INTERPRETATION

In Fletcher's tests he has purposely avoided intelligible words so as to eliminate intelligence (particularly memory). When actual words have been used occasionally as mentioned in the foregoing, there is less error in interpretation. In speech tests in which polysyllables or less familiar words are used, interpretation is more faulty. This forces one to consider familiarity, training and practice as important factors. Those who have lived in a foreign country will readily recall the difficulty

9. Miller, Dayton C.: The Science of Musical Sounds, ed. 2, Macmillan and Company, 1922.

they have had in interpreting the language in parts of that country with which they have not been familiar. The same is true to a degree in our own country with our own language. Training and practice, in short, repetition and familiarity, develop word memory.

THE AURIST'S INTEREST IN THE MENTAL SPHERE

The consideration of the higher processes of hearing rightly belongs to the domain of the psychologist, who is in a position to determine the value of the variable factors aforementioned. But before aurists attempt to measure the simple sensory exhibition of hearing, it is necessary that they should learn to apply their tests so as to eliminate these variables as far as possible. This can best be done by using hearing stimuli that call on the simplest mental processes. The person examined should be made to understand just what is wanted of him. It is desirable in making the test to note mentally the emotional sphere, to make a few preliminary remarks intended to put the patient at ease and yet prepare him to direct his sole attention to hearing and to replying promptly. Too much care cannot be given these matters, for "no detail in setting the test is too trivial to be neglected." [10] The examiner will finally adopt certain set phrases that are found to be most direct and suitable. With practice in making tests and with the repetition of these phrases, it will be found that the details are not as time consuming as might be supposed.

FACTORS TO BE CONSIDERED IN MAKING TESTS

Time Consumed in Making the Tests.—Here may be mentioned that constantly recurring complaint against the hearing tests—the time consumed. A careless and unintelligent examiner will take twice as long on a case as is needed; his results will be to his mind a confusion of conflictions. He is correct in believing that he has wasted his time. Systematic examination can be made promptly and accurately. The examiner should be familiar with a technic and should follow it.

Carefulness in Technic.—The difference between carefulness and carelessness can be illustrated as follows: The preparatory remark, "answer what you hear" brings an entirely different response from "I am going to say some numbers, answer quickly what you hear." The question "who is the president?" involves a mental process considerably longer than "what is your name?" or "where do you live?" Simple or "easy" questions give comparatively prompt responses, while those requiring some thinking may give an uncertain or hesitating response.

Slow Responses.—Slow reactions may signify one of a number of things: (1) The patient does not hear distinctly, (2) does not interpret

10. Whipple, G. M.: Manual of Mental and Physical Tests, 1914.

(cerebrate) quickly, (3) neither hears nor interprets well. From this it is obvious as one seeks to examine the simple sensory phenomenon of hearing that an "easy" question is better for this purpose as it requires less thinking. The answer is on the end of the tongue the moment the question is heard; if there is delay in response, one can more correctly infer that hearing is imperfect.[11]

Guessing.—Variety diminishes the chances of correct guesswork. Partially deaf patients, if asked to repeat the names of familiar things (such as cities or presidents), will often make a good showing by their clever guessing based on a mental filling-in of the unheard syllables. This is one of the few objections to the use of numbers as test stimuli; however, if numbers are not used in sequence, the chance of correct guessing is diminished. Memory must be guarded against by the avoidance of frequent repetitions.

Simple Voice Stimuli.—To repeat, the use of stimuli that call on the simplest mental processes eliminates to a large degree the variations in the observations due to the higher mental phenomena. For this reason numbers and common words are of more value than questions, though the questions are more useful in testing timid children. As to the words used, it is obvious from reasons of interpretation that simple monosyllables are more desirable than polysyllables. Chair, cat, coat, dog, door, boy, book, box, go, girl, hat, home, hut, luck, lady, lazy, tub, tack—all are examples of simple useful test words. It is well to vary words, mixing nouns, verbs, adjectives and adverbs.

In the following paragraphs will be seen to what an extent words differ as to their pitch, tone qualities and interpretability. Suffice it at present to say that in using simple words in a haphazard manner, the patient's audition must be judged by the general ability to hear and not by the particular hearing of certain words. Should an attempt be made to distinguish the patient's ability to hear words of various pitch, the test words must be selected with care and with a knowledge of their value.

The voice tests being the only method of testing the interpretation of speech, considerable benefit to the test can be seen in the choice of words most commonly used. It is naturally inferred that the words most used are most familiar. Carl C. Brigham of Princeton has inves-

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11. Andrews, B. R.: Am. J. Psychol. **15**:25, 1904; **16**:302-326, 1905. (Andrews attempts to apply Wolff's work to the English language. He uses a fixed hearing distance and numbers as stimuli, and grades the hearing by percentage of errors). Kerrison, P. D.: The Psychology of Deafness, Laryngoscope **25**:257 (He uses monosyllables as stimuli, and regards numbers and polysyllables as inaccurate). Politzer, A.: Lehrb. d. Ohrenh. 1893, p. 117. Bezold, F.: Schuluntersuchungen u. d. kindliche Gehörorgan, Weisbaden, 1885, p. 5, quoted by Whipple (footnote 10). Bezold, F.: Funktionelle Prufung d. Menochlichen Gehörorgans 1897, p. 206, quoted by Whipple (footnote 10).

tigated the frequency of words in all types of English literature, including children's books, classics, the Bible, elementary school books, books on sewing, farming and the trades, daily newspapers and correspondence, each type of literature being taken in a quantity proportionate to its amount of usage. Four million words were tabulated, and of these it was found that the following were the monosyllables that occur most

TABLE 1.—*Monosyllables among the First Five-Hundred Words in a Compilation of Four Million Words Graded as to Frequency of Appearance in a Wide Range of Literature, Books, Newspapers and Correspondence*

a	add	ask	air	all	am	an
and	any	are	arm	as	at	back
bad	ball	bank	be	bed	been	best
big	bear	black	bird	blow	blue	body
book	both	box	boy	bring	build	burn
but	buy	by	call	came	can	care
cause	child	clear	close	cold	come	corn
cross	cut	dark	day	dead	dear	death
deep	did	die	do	does	done	door
down	draw	drink	drive	drop	each	ear
earth	east	eat	egg	end	eye	face
fair	fall	far	fast	fear	feel	feet
few	field	fill	find	fine	fire	first
five	floor	fly	food	foot	for	form
four	free	fresh	friend	from	front	full
gave	get	girl	give	glad	go	God
gold	great	green	grow	had	hair	half
hand	hard	have	has	he	head	hear
heart	help	her	here	high	hill	him
his	hold	home	hope	horse	hot	hour
house	how	I	if	in	is	it
its	just	keep	kill	kind	king	know
known	land	large	last	late	laugh	law
lay	lead	leave	left	length	less	let
lie	lip	light	line	live	long	look
lost	love	low	made	make	man	many
mark	may	me	mean	meet	men	might
mill	milk	mix	mind	mine	miss	month
more	most	move	much	must	my	name
near	need	new	next	night	no	north
not	now	of	off	old	on	once
one	or	our	out	own	part	pass
pay	peace	place	plain	plant	play	please
point	poor	port	quick	rain	raise	reach
read	red	rest	rich	ride	right	read
rock	roll	room	round	run	said	sail
same	save	saw	say	sea	see	seem
seen	send	sent	serve	set	shall	she
strip	short	should	show	side	sight	since
sing	sit	six	so	soft	some	son
soon	sound	south	speak	spring	stand	start
state	stay	step	still	stone	stop	strong
story	street	such	sun	sure	sweet	take
talk	tell	ten	than	thank	that	the
their	them	then	there	these	they	thing
think	third	this	those	though	thought	three
through	till	time	to	too	top	town
train	tree	true	try	turn	up	us
voice	wait	walk	wall	want	war	warm
was	watch	way	we	week	well	went
were	what	when	where	which	while	white
who	whole	why	wide	will	wind	wish
with	wood	word	work	world	would	write
year	yet	you	young	your		

frequently among the first 500. In certain cases this list contains diphthongs, words with vowels when spoken produce two vowel sounds; but the number of these words is few. The list is useful for test purposes for the reason that the greater frequency of use of these words should make them more familiar and more readily interpreted without

an involved mental process. The vowel sounds in each word can readily be recognized, and their frequency values can be seen in the table of vowels.

This list in table 1 may be used in individual or group testing; the technic of both methods is described subsequently.

THE VOICE AS A HEARING STIMULUS

Coming now to the consideration of the more physical factors in voice tests, I shall give a detailed description of the voice as a hearing stimulus.

A study of the analysis of the spoken and whispered voice is unusually a revelation to the aurist. Yet it is most important that the aurist should know something about that which the ear is most called on to hear. The subject of the voice has been studied from a number of different angles. Chiefly it has been the philologists, physicists, physiologists, psychologists and vocalists who have discovered and developed what may be called the science of the voice.[12]

In describing the voice, it is well to review a few of the fundamental principles of sound.

Sounds are tones or noises. Most sounds are complexes of single tones. If these tones are rhythmic and complementary, they are said to be musical; if not complementary, they are discords; if not periodic or rhythmic they are said to be clang tones or noises. Individually, noises are of short duration though they may appear to be continuous if they are generated from a source continuously throwing them out. Consonants with certain exceptions are noises; vowels are complex musical tones.

Each single tone in any sound has these characteristics: 1. Pitch, or frequency, designated by the number of vibrations per second. 2. Amplitude, the amount of the excursion of the vibration. 3. Loudness or intensity, which is expressed mathematically by the square of the product of the pitch times the amplitude $I = (nA)^2$.

The amplitude of the voice is obviously primarily dependent on the air blast used in phonation, though considerable alteration occurs through the position of the accessory vocal apparatus. It is on account of both the variability in amplitude of the voice and the inability to produce definite monotones that the value of the speech tests is greatly reduced. It is certainly on this score that the tests can be severely criticized. If it is impossible for an examiner at consecutive sittings to duplicate his testing stimuli, it is impossible to obtain results that are comparable.

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12. The well-known names in this work are Koenig, Bezold, Helmholtz, Lord Rayleigh, Winklemann, Seashore, Scripture, Bevier, Dayton C. Miller, Pohlman and Fletcher. An excellent bibliography may be found in Miller's "The Science of Musical Sounds." In this book the methods of voice analysis are fully illustrated and carefully described.

Frequency.—As most sounds are combinations or complexes of tones, many different frequencies or pitches may exist in what appears to be a single tone.

Vowels.—It has already been stated that spoken words are characterized chiefly by their vowel sounds. "The vowel is the heart of the word." It is a complex tone combination of various pitches having various amplitudes. To demonstrate the purely physical qualities of the vowel, Miller has selected for analysis the vowel "a" as it is pronounced in the word "father." Intoning this vowel, the voice was used to produce the oscillation of a small mirror against which impinged a beam of light. The graph thus made was analyzed into its components. At first a voice was selected that intoned the vowel at different pitches; then voices of different register were recorded. The results were interpreted in terms of pitch and amplitude. In each record there is a complex of numerous tones of varying pitch and amplitude. Thus, in one instance in which the vowel was intoned on the frequency 159 (D_2 sharp), the first ten components of the curve had the following amplitudes, corresponding to a wave length of 400: (1), 4; (2), 15; (3), 18; (4), 12; (5), 20; (6), 60; (7), 21; (8), 16; (9), 2; (10), 3.

In this curve there were six distinct subpeaks of frequencies on one wave, and the sixth partial was prominent. Since the frequency of the fundamental was known to be 159, that of the sixth partial is 954 (A_4). "The diagrams indicate that there is not a fixed partial which characterizes the vowel, neither is there a single fixed pitch. The greater part of the energy of the voice is in those partials that fall within certain limits, no matter at what pitch the vowel is uttered, nor by what quality of voice; that is, the vowel is characterized by a fixed region, or regions, of resonance or reenforcement." To those unversed in the knowledge of musical sounds, this simply means that vowels have a variety of frequency sounds, some loud and some faint, but the greater part of the sound, or the strongest pitches, occupies a certain distinct region in the tone scale. The complexity of pitches and amplitudes gives a certain musical color to even single vowel sounds. If this is true of one vowel, it is easy to realize that words and sentences are colorful sound pictures.

What does this mean to an examiner testing partially deaf subjects?

In understanding language through hearing, an excellent analogy can be drawn with vision. Let it be supposed that a water-color picture is on view; it has color tones of great number and of great variety in value, but in this particular picture the blues and reds predominate. A person blind to one or both of these colors, on seeing the picture takes some time to discover what it represents, while a person with normal sight can tell immediately. Likewise, language presents to the ear a

multitude of complex tones of varying pitch, intensity and color. If hearing is imperfect, part of the hearing picture does not reach the consciousness, and to what is heard has to be added what the mind infers in order to complete the picture intelligently. With defective hearing it may not be possible for the subject to make the picture complete. "He hears something but cannot tell what it is." Mental processes endeavoring to interpret accurately may be alert, a credit not usually given to the deaf, but response is slow or erroneous.

Characteristics of Consonants.—Though the vowel sounds in a word give it its chief characteristics, yet consonants can be of enormous importance in the matter of correct interpretation of speech. For this reason, if one is to derive any knowledge of word-hearing through experiments in word interpretation, it will be necessary to know something of the consonants.

The twenty-three consonants in the English language are classified either according to their sounds or according to the molds which the vocal apparatus takes to produce them. Classified as to vocal moldings, *P, B, M, Wh* and *W* are labials; of these *B. W* and *M* are voiced sounds having resonance; *P* and *Wh* are breath sounds and do not use any laryngeally produced sound. *F* and *V* are labiodentals, the former voiceless, the latter voiced. *Th* as in "thing" and *Th* as in "they" are linguodentals, the former voiceless, the latter voiced. *S. Z, Sh, T, D, N, L* and *R* are called anterior linguopalatals; *S, Sh* and *T* are voiceless, the others are voiced. *K, G, Ng, H.* and *Y* are posterior linguopalatals; *K* and *H.* are voiceless, the others are voiced.

It must be understood that the consonants do not sound in speech as they do in the recitation of the alphabet; many take on characteristics depending on vowels that precede or follow them; others, those voiced, are of the nature of diphthongs, being composed of two or more component sounds, namely, $G = D$, *Zh* and *E*. To clarify the understanding of vowels from a physiologic point of view, Neil Arnott has constructed a physiologic alphabet, which, modified by John Wylie of Edinburgh and G. Hudson Makuen of Philadelphia, has been evolved into table 2.

What are the characteristics of consonants and vowels operating together as speech? Fletcher's work in audiometric studies has led him to the conclusion that "although most of the energy in speech is carried by frequencies below 1,000, the essential characteristics which determine its interpretation are carried by frequencies above 1,000 cycles. In ordinary conversation the sounds *Th, F* and *V* are the most difficult to hear and are responsible for 50 per cent of the mistakes of interpretation. The characteristics of these sounds are carried by the very high frequencies."[8] In testing hearing by the spoken or by the whispered voice, obviously one is only testing hearing in the range of the voice,

300 double vibrations to 3,000 double vibrations, and one is probably testing hearing only in a part of this range. The limits of hearing are generally accepted at 16 double vibrations to 26,000 double vibrations, and pathologic changes of hearing, though usually affecting the whole range to some degree, are most demonstrable in their effects on the upper or lower limits. Here then is a natural limitation of the voice tests.[13]

TABLE 2.—*Physiologic Alphabet*

Consonants

	Voiceless Oral	Voiced Oral	Voiced Nasal	
Labials	P Wh	B W	M	Paul Brown makes white wax
Labiodentals	F	V		Full voice
Linguodentals	Th′	Th″		Think thou
Anterior linguopalatals	S Sh T	Z Zh D L R	N	Some zelous sheep leisurely took down nine large rails
Posterior linguopalatals	K H	G Y	Ng	Can girls bring home yeast?

Vowels

ă	ā	le	ō	ō	ld			
ă	ā	t	ŏ	ŏ	n			
ă	ā	lms	o͞o	o͞o	ze			
a	a	ll	o͡o	l	o͡o	k		
a	a	sk	ĭ		lt			
ē	ē	ve	u		ŭp			
ĕ	ĕ	lk						

Coalescents

a͞r	f	a͞r	e		o͞r	f	o͞r	e		
a͡r	f	a͡r			o͡r	f	o͡r			
e͞r	h	e͞r	e		o͞or	p	o͞or			
e͡r	h	e͡r			u͡r	p	u͡r	r		

Unfortunately, statistics on the values of the voice sounds expressed in terms of frequencies, depend greatly on the individual pronounciation. "Any change in the pronounciation gives a different vowel, though we may understand the word to be the same, and the quantitative results vary for the slightest change in intonation or inflections." [9] Compare these notes with the clinical observations given later.

SELECTION OF TEST WORDS

It is confirmed from the foregoing facts that monosyllables are better test stimuli than sentences. Obviously, much depends on the sound values of the test stimuli. For this reason many authors have suggested

13. Bross, K.: Ueber die Bezold'sche Sprachsexte, Passow's Beitr. **9**:70-81, 1917. (Bross observed in studying deaf-mutes that Bezold's essential hearing range for human voice perception, B_1-G_2, is not correct. Frankfurter and Thiele: Experimentelle Untersuchungen zur Bezold'schen Sprachsexte: Internat. Zentralbl. f. Ohrenh. **11**:172-173, 1913.

sets of words or numbers. Most of this work is in foreign literature, in languages other than English, and is practically useless. Andrews [11] has made an attempt at the application of Wolff's [14] (German) work to the English language. In Italy, Gradenigo and Stephanini have been foremost in this work in Europe.[15]

In the use of words as test stimuli, it is permissible to stress the vowels and to elide the consonants, for, as is already understood, the vowels give the characteristics of the word and are more standardized as to their musical nature and constancy. The patient's answers should be judged by their correctness in reporting the vowel sound, and not by their exactness in reporting the very word. Thus the test word "pat" reported as "mat" is recorded as correct for this stimulus given at the hearing threshold. In short, the patient's ability to distinguish vowel sounds is tested.

Following are two lists of words that I have found to be simple, practical and of great utility in determining the faults in the interpreta-

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14. Wolff, O.: Tr. by Holden: Arch. Otol. 1890, p. 298. The test words used by Wolff are in German, and consequently have only a relative value for similar sounds in English.

15. Gradenigo and Stephanini: Studi e proposte id acumetria, Fourteenth Congress of the Italian Society of Laryngologists, Arch. Ital. di Otol. 1912. Gradenigo: Vorschläge zur Akumetrie, Ninth Otological Congress International Boston, 1912. Gradenigo proposes the use of the vowels u, o, a, e, i, Italian, pronounced loudly and softly. The fractional relation between the normal hearing distance and that of the patient he calls the vocal index for each vowel. Gutfreund: Wien. klin. Wchnschr. **29**:450, 1916. Kikuchi, J.: Contribution to the Testing with the Whispered Voice by Japanese, Annual meeting, Japanese Otological, Rhinological and Laryngological Society, Tokyo, 1906, Internat. Zentralbl. f. Ohrenh. **5**:415, 1907. Monkewa, H. F.: Ueber den Gebrauch von Wörtern mit Doppelvokalen bei Gehörschärfebestimmungen nach der Methode der drei Brüche, Ztschr. f. Ohrenh. **51**:120, 1906. (Results from the physiologic clinic of Utrecht according to the methods of Zwaardemaker and Quix, for determining the acuteness of hearing with whispered voice, in the Dutch language.) Morsak, Karl, Hörprüfung mittels Sprache am gesunden und Kranken Ohr (Examination of Hearing through Words in Normal and Pathologic Ears), Arch. f. Ohrenh. **68**:101-121 and 161-208, 1907; **69**:1-26, 1907. (From the examination of normal and pathologic ears Morsak has found that number 7 is heard best and at greatest distance, 100 is heard worst. Numbers 7, 4, 82, 6 and 3 have longer hearing distance than 9, 5 and 100. In the tonal scale 2, 6 and 7 are in the highest parts; 8 and 3 in the middle, 9 and 100 in the lowest region; 4 and 5 are heard as well in the upper as in the lower registers. In diseases of the sound conduction apparatus, the deep toned numbers are least well heard. In perceptive deafness 7 is not heard as well; 4 and 5 are also heard poorly. The results of the examination by words correspond in all groups with the results by other methods, so that whispered words may be used in testing diseases of the ear in order to get a first survey. Tonsetti: Hearing Tests with the Whispered Voice in Comparison with the Chief Italian Acumetric Scales. Eleventh Congress, Italian Society di Lar. etc. Rome, Oct. 1907; abstr., Ztschr. f. Ohrenh. **6**:100, 1908. Wajatschek: Die heutige Hörprüfung vermittels der Sprache, Russk. Vrach, 1906, no. 2, Arch. f. Ohrenh. **69**:151, 1906. Following the suggestion of Quix at the Int. Congress at Bordeaux, 1904, Wajatschek has gathered together a number of words for examination in Russian. Brande, G.: L'esame funzionale del labirinto acustico e non acustico, Atti 1909, Arch. f. Ohrenh. **84**:110, 1911.

tion of speech. The first list uses low-pitched vowel sounds; the second contains the high vowel sounds.

Set A is composed of vowels of single frequency; the words are adapted from the work of Dayton C. Miller on vowel values. "The vowels *ma, maw, mow, moo* have maximum resonances at pitches 910, 732, 461 and 362, respectively. The resonance regions overlap but little, and the partials lying within a characteristic region of resonance often contain as much as 90 per cent of the total energy of the sound; there is a conspicuous total absence of higher tones and all the lower tones are weak; the fundamental is of small intensity, containing only about 4 per cent of the energy, unless its pitch lies within a region of characteristic resonance. The vowel *ma* seems to have considerable range, as its characteristic may vary from 900 to 1,160."

TABLE 3.—*Set A*

ma	ah	hah	pa	ta-ta	910-1050
maw	awe	haw	paw	taw	732
mow	oh	hoe	poe	toe	461
moo	you	who	pooh	too	326

Set B, the second class, is composed of relatively high voice sounds, 1,050 to 3,100. In this set each of the vowels have two characteristic regions of resonance ("*mot*" has a single resonance in addition to its double resonance). "The lower resonances are practically the same as for the vowels of the first class, but contain only about 50 per cent of the energy, while about 25 per cent is in the higher region. The lower and intermediate tones are stronger than in the vowels of the first class, the fundamental often containing 10 per cent of the energy. Although each vowel is characterized by two fixed regions of resonance, the distinguishing characteristic is the higher resonance."

TABLE 4.—*Set B*

mot	pot	not	lot	1060 (single) 960 and 1240
mat	pat	gnat	lat	800 and 1840
met	pet	net	let	691 and 1953
mate	plate	Nate	late	488 and 2461
meet	Pete	neat	fleet	308 and 3100

Numbers as Test Words.—Avoiding their use in sequence, the numerals from "one" to "ten," perhaps with the omission of "seven," will be found sufficient for testing adults. Their normal value varies with each individual examiner, but roughly they may be graded as in table 5.

Seven may be omitted for three reasons: 1. It is a polysyllable, and will readily be guessed by a patient conscious that the test numbers are running from 1 to 10. 2. Ten contains the same vowel, *e*, as 7, in

which *"e"* is repeated. 3. The high pitched *"s"* of 6 is also equivalent to the *"s"* of 7.

Intensity or Loudness of Numerals and Words.—The probable intensity of numerals and words depends largely on the strength of the voice used by the examiner. Resonance is a minor factor, as is articulation. As the latter aids in the distinctness of hearing, it belongs to the interpretation sphere. It is, however, bound up in an inseparable manner with the voice tests. Though loudness or intensity depends equally on pitch and amplitude ($I = nA^2$), from a practical point of view amplitude will be the most important in most cases. It is impossible for an examiner to maintain an even vocal strength. The nature of speech makes this impossible, for the parts of one word cannot be spoken

TABLE 5.—*Values of the Numerals as to Pitch*

1	461	"mow"
2	326	"moo"
3	308-3,100	"meet"
4	762, 691, 1,953	(a diphthong, ff, awe, err)
5 and 9 are similar diphthongs (a, ē)		a, 1,050 awe, 762; err, 691-1,953 e, 308-3,100 "meet"
6	? highest	
7, 8, 10	2 fixed regions of resonance	7, 691 and 1,953 "met" 8, 488 and 2,461 "mate" 10, 691 and 1,953 "met"

with equal intensity. Bunch [16] found no great agreement when he compared the results of six or eight examiners who had been "instructed as carefully as possible" in the various phases of the work. These examiners were regularly occupied in examination, and yet could not duplicate each others results.

The whispered voice is usually delivered without the production of any larynx tone. The intensity can best be controlled by the use of the residual air in the lungs. The musical characteristics of the whisper are an absence of fundamental or pitch, "and without the series of partials which determine the individuality of the voice." [9] The curves reproduced from whispers show mainly one frequency—that characteristic of the vowel. Though the comparisons in table 6 show a somewhat greater frequency for whispered voice as compared with spoken voice, the amplitude of the tones in the latter make a greater intensity (loudness) of sound, thus greater audibility.

16. Bunch, C. C.: University of Iowa (personal communication). Results Obtained from One Year's Use of the Audiometer in the Otological Clinic, Laryngoscope **31**:137 (March) 1921.

Comparisons of forty-five curves of whispers show frequencies for the characteristics as given in the table; the frequencies as determined by analysis of the spoken vowels are also given for reference. It appears that the resonance frequency of the mouth in whispering is somewhat higher than when speaking, though the whisper characteristics are well within the limit of those of speech (Miller).

Whispering reduces the intensity of the vowels, whereas the consonants are little changed; its testing range is from 17 to 40 meters, or about one-third that of vocalized speech.[10] Extraneous noises make a greater difference with the whisper test than with the spoken voice test. There is little choice between the whispered and spoken voice methods; in each it is hard for the examiner to control amplitude.

TABLE 6.—*Greater Frequency for Whispered than for Spoken Voice*

Vowel-	ma	maw	mow	moo	mat	met	mate	meet
Whisper, n.....	1,019	781	515	383	857 1,800	678 1,942	488 2,385	391 2,915
Analysis, n.....	922	732	461	326	800 1,843	691 1,953	488 2,461	308 3,100

INDIVIDUALITY OF THE VOICE

Enunciation, accent, articulation and inflection characterize individual voices and enter into the voice test as variable factors. Another factor, which though related to enunciation and inflection is somewhat apart from them, is the personal variation in the use of the human vocal resonators, the nasal chambers, accessory nasal cavities and the mouth. These accessory mechanisms alter the vocal quality enormously. It seems that the peculiarities of individual voices are altogether dependent on them, and on their influence on the particular overtones in the larynx sound.[9] It has previously been stated that speech is characterized chiefly by vowels, and that vowels do not have a single fixed pitch but have a fixed region of resonance which is independent of the fundamental tone of the vowel.[9] This is the so-called fixed pitch theory of Helmholtz. Opposed to it is the theory that vowel quality (as well as all tones of musical instruments) is characterized by "a particular series of overtones accompanying the given fundamental." This is the relative pitch theory. The two theories have caused much discussion; the Helmholtz theory has been largely accepted until recently.[17] However, it is obvious to those carefully observing the voice tests that the quality of speech makes a great difference in interpretation. As quality depends on overtones, and as overtones depend largely on the characteristics of the

17. Bevier, L.: Analysis of Vowels, Phys. Rev. **10**:193; **14**:171, 214; **15**:44, 271; **21**:80. Scripture, E. W.: Researches in Experimental Phonetics, Washington, 1906, pp. 7 and 109.

resonators, it may be judged that the use or lack of use of the human resonators are important factors in the character of the voice. Here are some variable largely beyond control.

Extraneous Factors in the Voice Test.—It is most important to remember in making the tests that the acoustic properties of the examining room may alter results. There may be sound absorption (dampening), reflection, echo (reverberation) or interference by other sounds. Some of these factors affect the intensity and duration of the sound from the testing source, some affect the attention of the person examined. Such factors as follows are commonly encountered, namely, variations in the size of the room, the height of the ceiling, the presence of open or closed doors or windows, hangings, furniture and carpet. It is not hard to understand why one examiner reports his results for normal hearing as 20 feet, while another reports 30 or 40 feet. Many extraneous factors cannot be eliminated, but all should be made as unchanging and standard as possible. This can only be done by seeing that the "set" of the test is repeatedly identical. The patient should be away from the walls, seated in the middle of the room and faced so that the ear to be tested is turned in the direction of the examiner. The untested ear should be "stopped" by the patient's finger. Generally speaking, this is advisable in all cases, although stopping the untested ear increases slightly the hearing in the tested ear. It is well to make sure in all speech or voice tests that the patient cannot see the examiner's lips; this may be accomplished by turning the patient, by covering his eyes with the hand, by blindfolding or by covering one's own lips while speaking. In the report, a brief comment should always be made as to the circumstances of the test, thus: "My usual examining technic, no noise, no interruptions" or "street noises are disturbing hearing and attention, otherwise 'set' is normal."

FATIGUE

Auditory fatigue may be either a purely sensory or a perceptive phenomena. In sensory fatigue, Albrecht [18] has found that by permanent irritation of the ear through a sufficiently loud pure tone (with harmonic overtones) in the fifth to the ninth octave, a certain but transitory diminution is caused in auditory acuity. Accompanying this fatigue there may be evidences of auditory nerve irritation, such as lingering of tone, feeling of fulness in the ear and oversensibility of the ear to external sound stimuli.

After-images are not likely to appear in the voice tests, but sensory fatigue is frequently produced by shouting in the patient's ear. A loud volume of sound is likely to produce an auditory sensation of "dulness"

18. Albrecht, H.: Zur Frage der physiologischen Ermüdbarkeit des Hörnerven. Passow's Beitr. **13**:202-229, 1919.

or dampening, and frequently gives a tactile sensation of tingling or itching in the canal. Secondary hyperacusis, or the sense of irritation from further noises, is seldom seen; rather the reverse is found.

The so-called "radio ear" had been observed in the auditory reactions of "trouble-shooters" or testers in telephone work prior to the advent or the common use of radio sets. These men obtain what may be called for want of a better terms, a consciousness of their ears; there is a sense of fulness or stuffiness, a loss of perception to a small degree for low tones and a hyperacuity for high tones; finally, a transitory but certain attention fatigue may develop. The cause is not only an attention to high pitches such as the telephone circuits use, with a negation or indifference to low pitches, but there is also a physical fatigue from the overstimulation of audition with tones of strong amplitude, for telephone sounds are relatively loud to the ear with normal hearing.

Fatigue as a perceptive phenomenon has been demonstrated by the psychogalvanic experiments of Veraguth. Albrecht,[3] who has followed up this work, arrives at the conclusion that patients suffering from organic (sensory) deafness do not react, whereas patients suffering from psychogenic (perceptive) deafness react distinctly. The test consists in bringing the patient within the circuit of a low tension galvanic current to which a wire-coil galvanometer is attached. Endosmotic processes are stimulated by auditory stimuli that will cause variations in the galvanometer. Such variations are also set up by light and by tactile irritations. The results are not affected by the volition of the patient, whose responses, if negative, are known to be due to fatigue or stimulation. Goebel [4] has confirmed Albrecht's work.

In testing the fatigue in school children in a general way, Remy reports that hearing is better at the beginning of the lessons than at the end. The ear fatigues more quickly than the eye; therefore hearing tests are a better index of mental fatigue than are visual, tactile or muscle tests. Central auditory fatigue shows itself as an inability to sustain attention. Every examiner will observe the phenomenon if he puts his patients through long testing séances.

A number of observers have recorded a variation in audition according to the time of day, and it has been shown that the sharpness of hearing of the same person is rather constant at the same time on different days. Bachrach [19] found the best hearing time at 6 p. m.; a second optimum seems to exist in the early forenoon. In some subjects the hearing is worse in the morning. These factors, whatever their cause, are antithetic to the obvious fatigue of the working day.

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19. Pohlman, A. G., and Kranz, F. W.: Ann. Otol. Rhin. & Laryng. **32:** 545-553 (June) 1923.

CLINICAL OBSERVATIONS WITH WORD TESTS IN CATARRHAL DEAFNESS

In testing patients with catarrhal deafness, it must be remembered that as deafness becomes permanent, and as it reaches the actual stage of "hard of hearing," a progressive diminution appears in the central perception from the disuse of the hearing centers. Association pathways are less alert, and it is reasonable to suppose that many of the delicate nuances of word memory disappear. Thus, studying subjects individually, more or less variety in the ability to hear certain words may be seen; but studying them grossly and collectively, the subjects present a distinct difficulty of hearing for each word.

A list of test numbers spoken at a distance at which hearing just becomes distinct (threshold distance of hearing perception) is given in table 7. After each number is a notation of errors of interpretation and omissions, the latter being noted when the test word is not heard.

TABLE 7.—*The Results of a Record of 740 Tests*

Test Numbers	Errors, Percentage	Omissions, Percentage	Frequencies
1	0.9	5.4	600, 800
2	1.2	19.0	300
3	2.5	27.0	500, 2300, (r, 500, 1200)
4	0.65	8.1	600 (r, 500, 1200)
5	2.5	8.1	910, 1050, 300, 2300
6	1.2	8.1	400, 2300
7	1.3	9.4	500, 2300
8	2.8	17.5	300, 1800
9	1.3	13.4	910, 1050, 300, 2300
10	2.5	17.5	500, 2300

Frequency of omissions.....13.39%; order, 1, 4, 5, 6, 7, 9, 2, 10, 8, 3
Total errors of perception..... 1.68%; order, 4, 1, 2, 6, 7, 9, 3, 5, 10, 8

TABLE 8.—*Sample Test Record for Word Hearing in a Case of Catarrhal Deafness* *

	Monochord (Struycken-Schaefer) AC 16,000													
Right Ear	Spoken Voice, Threshold Distance, 3 feet												E	O
1	1	1	0	1	0	1	1	1	1	1	1	1	0	2
2	2	2	0	0	0	0	2	0	2	2	2	2	0	5
3	0	0	0	3	0	0	0	3	0	10	0	3	1	8
4	4	4	0	4	4	4	4	4	4	4	4	4	0	1
5	5	0	5	5	5	1	1	5	9	0	5	0	3	3
6	6	6	6	6	6	6	6	6	6	6	6	10	1	0
7	7	0	7	7	7	7	7	7	7	7	7	7	0	1
8	0	0	0	7	0	0	0	8	8	8	0	0	1	8
9	0	1	1	0	1	0	0	0	0	0	0	0	3	9
10	0	0	6	10	6	0	11	4	7	6	0	10	6	4
	Total..... 120												15	41

* Y. C., a girl, aged 15, was alert and intelligent. The setting for the test was quiet and my usual "set."

From the figures in table 8 it will be seen that although certain numbers are characterized by the same vowels having identical vowel frequencies, yet neither the hearing nor interpretation of these words

correspond. With test numbers that show more than one frequency, the strength of the tone is largely confined to the higher frequency, and the interpretation of the whole is largely dependent on the hearing of these higher tones. The figures *3, 5, 6, 7, 9* and *10* have the frequency 2,300; the chance of error in interpreting these numbers is respectively, 2.5, 2.5, 1.2, 1.3 and 2.5 per cent—an average of 1.9 per cent. Figures *1, 2* and *4* are characterized by low frequencies, 600, 300 and 600, yet interpretation of these numbers is respectively 0.9, 1.2 and 0.65 per cent, an average of 0.9 per cent. In comparing, then, the figures for low and high frequencies, it is seen that patients with catarrhal deafness hear the low tones much better than they do the high tones. The higher the frequency in vowel sounds, the greater is the error in interpretation. Yet six and seven are high frequency words and are heard relatively well, as they are in all types of deafness. Their vowel frequencies are nearly identical, and both contain the high pitched *s* as the predominant consonant. It is probable that this letter makes these words more intelligible, which can be explained only on the grounds of its amplitude, not its pitch.

One and 4 are low frequency and are heard best; 8 and 3 show the greatest difficulty and are often mistaken for one another.

Peculiar characteristics appear in studying cases individually. Thus in a patient with catarrhal deafness in whom the disease seems to be of equal grade in both ears, a test number may be interpreted correctly many times by one ear with frequent errors by the other. It seems impossible to ascribe certain repeated errors to any other cause than marked deafness in particular regions; in other words, the deafness does not appear to be a uniform decrease in hearing throughout the range, but assumes peaks and dips in plottings of hearing. This confirms the observations of Dean and Bunch and of Kranz with their audiometers.

It will be found relatively easy to strike on the distance which gives the threshold of hearing for the particular patient. It is important to note this distance in the record, and it is equally important to record the omissions of hearing as an index of the sharpness of this threshold. The number of omissions is of paramount interest in considering the number of errors. Correctness in interpretation is seen to be somewhat proportionate to the hearing at the threshold. When omissions are more frequent, the percentage of misinterpretation is higher. Occasionally subjects are seen in whom interpretation is always correct if the word is heard at all.

It was found that the use of 100 test stimuli to each ear at one examination does not give any evidence of fatigue. It is certain that word tests do not fatigue the patient with the rapidity that single tone tests do, such as the tuning fork tests. This might possibly be explained on the hypothesis that the single tone produces repeated stimulation of but

one small portion of the membrana tectoria, that of its own frequency, while the voice has a variety of tones.

CLINICAL OBSERVATIONS WITH THE VOICE TEST IN PATIENTS WITH NERVE DEAFNESS

Using the numbers 1 to 10 as test stimuli with the spoken voice at distances in the individual cases at which audition begins to become distinct, the results seen in table 9 were obtained.

TABLE 9.—*Results of the Voice Test in Patients with Nerve Deafness*

Stimuli Spoken Voice	Errors, Percentage	Omissions, Percentage	Frequencies
1	1.8	6.6	600, 800
2	3.0	1.0	300
3	2.5	13.3	300, 2300, (r, 500, 1200)
4	2.0	13.3	600 (r, 500, 1200)
5	4.6	23.3	900, 1050, 300, 2300
6	1.6	9.3	400, 2300
7	3.5	6.6	500, 2300
8	3.1	9.3	300, 1800
9	5.5	15.0	910, 1050, 300, 2300
10	5.6	10.0	500, 2300

Number of tests, 600
Percentage of total errors, 3.32
Percentage of omissions, 11.67
Order of interpretation, 1, 6, 4, 3, 2, 8, 7, 5, 9, 10
Order of frequency of omissions, 1, 7, 6, 8, 2, 10, 3, 4, 9, 5

At the threshold of hearing, patients with nerve deafness make more errors than do those with catarrhal deafness. Both interpret *1, 6* and *4* well. One and *4* are relatively low speech tones. In patients with catarrhal deafness, interpretation of these tones is better than in those with nerve deafness, the relative ability in each condition being represented by the relation 0.77 : 1.9. But "2," which is also a low tone (300 double vibrations), is heard poorly in each condition, with 12 per cent error in catarrhal deafness and 3.0 per cent error in nerve deafness.

The high tones are heard more poorly at the hearing threshold by the patients with nerve deafness than by those with catarrhal deafness. Thus 9 and 10 are high speech sounds, the highest of this series, yet they show an error of interpretation of 5.5 and 5.6 per cent. In catarrhal deafness the factor of error for *9* is 1.3; for the test-word *"5,"* the vowel of which has the same frequency, the factor is 2.5; the factor for *10* is 2.5. In nerve deafness the factor for *5* is 4.6. It is obvious, then, that there is a decided difference of interpretation in favor of catarrhal deafness.

It is difficult to reduce to a terse form all the facts that concern the standardization of the speech tests. An intimate knowledge of the whole subject will lead to a subconscious avoidance of many of the variable factors, and will develop an invariable technic that will make those variables that cannot be eliminated more dependable. It is important to epitomize a practical technic for making the voice tests.

TECHNIC FOR VOICE TESTS

1. The record sheet should contain the usual brief of age, occupation, chief complaint, family history, previous medical history and the history of the present illness. It is surprising how full and instructive even a few lines on the above topics can be.

A short note on the physical examination of the ears, nose and throat should follow. To this can be added any remarks on the outstanding general condition that may appear to be relative to the subject. For the hearing tests it is most important that the nervous stability should be noted. This should never be omitted from the record of any hearing test, since it means so much in the interpretation of the results. There should now be added some comment as to the set of the test. Thus: "Subject is alert and intelligent," "the setting was standard and quiet." (By "standard" is meant the setting that one familiarly uses. Though this remark may mean nothing to others who read the records, it avoids lengthy notes and means much to the examiner.) Again one may note: "The subject is ignorant and slow, test slightly disturbed by street noises and by constant interruptions;" or, "the subject is of the neurotic, nervous, erratic type; responses were alert, and the setting was quiet."

2. The hearing stimulus used should be mentioned. Thus: "Stimuli, numbers 1 to 10;" "stimuli, test words monosyllables;" "stimuli, simple questions."

3. "Set" of the test: The room should be quiet and as free from all distractions so far as possible; extraneous noises should be minimized and interruptions avoided. The patient should be seated preferably in the middle of the room away from the walls, and should be facing at right angles to the direction of the sound, that is, the tested ear should be turned toward the examiner. The untested ear should be stopped by the patient's moistened finger. The pressure of the finger should be gentle, not firm, and just sufficient to occlude the canal. Strong pressure affects acuity in the opposite ear.[18]

4. The floor or baseboard should be chalked off in feet or meters distant from the patient. Hearing distance is recorded and set down in its relation to the normal hearing distance for the same stimulus. The ratio sign is used (:), not the fraction sign (/).

5. The examiner who has cultivated a monotone of intensity commensurate with the size of the room should approach the patient from the inaudible to the audible limit. He should speak or whisper as he approaches, not the same stimulus, but variations of the stimulus. There should be no effort at emphasis or inflection, but articulation of the vowels should be clear, not slurred. With the whispered or spoken voice, the use of the residual air gives a greater uniformity in the intensity or loudness of the voice.

6. A few preliminary tests should be made in order to familiarize the patient with the experiment, and in order that the examiner may strike a satisfactory monotone. Some minor details of error that can be corrected by these preliminary tests are usually found.

7. Successive repetitions of the same test stimulus should be avoided and as far as possible all factors that call to any extent on "the higher auditory centers."

8. Tests should be repeated for the confirmation of results, but repetition should not extend to the point of fatigue.

9. A variety of from five to ten test words should be used for each distance before conclusions are formed as to the hearing at this distance.

10. The test should be postponed if for any reason uncontrollable mental or physical variables of extreme degree enter, for example, crying spells, stubbornness (in children), antagonism of the patient, malingering, obvious guessing, extreme confusion, distraction or fatigue, inability of the examiner to maintain a monotone or disturbing extraneous noises or interruptions.

11. The introduction of any variables in the technic is valuable information and should be noted.

SPEECH INTERPRETATION TESTS

There is a threshold of minimum audibility in the hearing of the voice, in other words, as the examiner approaches the patient, there is a distance at which some words begin to be distinguished. In testing the ability to interpret speech, the tests are made at this hearing threshold and record is made of the words used as stimuli and the words as interpreted. In making such tests, it is possible to determine for which speech tones the hearing is lost. The correct answers as well as the character of the misinterpretations is the information desired.

In this text an office record card printed on both sides is illustrated, the first sheet being for the history and the reverse being for the hearing test record. The method seems accurate, rapid for recording and readily interpreted. It is inserted here, not to add to the already numerous record sheets recommended, but to serve as an illustration of the type of record that may be adopted or adapted by any examiner.

Results in the schema mentioned are recorded as follows:

Record the time for the tuning forks in seconds heard from the time that the fork is struck a normal or standardized blow; note the normal hearing distance.

Record the Galton whistle in terms of its markings.

Record the monochord in terms of thousands of double vibrations.

Voice tests are recorded under "threshold" in either the English table of lengths or in the metric system. The normal hearing distance is always noted. Summarize the totals of stimuli given, errors and omissions made.

Concluding the description of the technic of the foregoing tests, it is again emphasized that the greatest care should be exercised in selecting, practicing and rigidly maintaining an ideal technic. "Aim to select the most favorable conditions and control these by keeping them constant" (Bunch).

Enumeration of factors and variables that reduce the efficiency of the voice test as a means of estimating the degree of hearing:

1. Limitation of the pitch range of the voice, 300 to 3,000 double vibrations, whereas the hearing radius is 16 to 26,000 double vibrations.

2. Complexity of pitch, amplitude and quality of voice sounds.

3. Impossibility of repeating or continuing identical test conditions, (*a*) lack of control of the amplitude, thus the loudness; (*b*) importance of accent, inflection and enunciation; (*c*) possibility of variations in technic; (*d*) the voice as a producer of hearing stimuli is grossly imponderable, uncontrollable, not dependable and not subject to exact analysis or valuation; (*e*) importance of surrounding acoustic properties when testing and their tendency to vary.

4. The importance of mental factors in the voice test; intelligence and memory; educated association pathways.

5. Voice tests are tests of understanding and interpretation as well as of the simple sensory phenomena of hearing. Yet the test is usually thought of as one to determine hearing, not interpretation. It is difficult to eliminate the factors of the higher mental characteristics in testing.

VALUE OF VOICE TEST IN DIFFERENTIAL DIAGNOSIS OF TYPES OF DEAFNESS

While the voice test has a rough value in determining the deafness to whispered or spoken voice, it is of no great or sure value in the differential diagnosis of the different types of deafness, the reason being that high voice sounds at the interpretation threshold are heard nearly equally well in all types of deafness. Further, the voice range is not sufficiently high in its upper limits to test high tone deafness in a satisfactory manner. The popular idea that a differentiation can be made by the voice tests between nerve and catarrhal deafness is not borne out by careful experiment. All that can be said of any contrast in the two major types of deafness is that interpretation is somewhat better in catarrhal deafness than in nerve deafness (ratio 30:65 :: 45:65); patients with catarrhal deafness interpret high tones decidedly better than do patients with nerve deafness (ratio 30.4 : 70); the same is true to a less degree with the low tones (ratio 26.9 : 58).

Comparison of Voice Test with other Hearing Tests.—Tests other than the voice test call on simple and single auditory qualities to test hearing; the forks and cylinders use single pitches of simple musical character. They always produce the same tone and have a certain initial amplitude that dies away. The whistles and the monochord are also comparatively simple, colorless stimuli with the added feature of the possible variation of the pitch. The audiometers of Iowa Univerity (Dean and Bunch), of John Guttman and of the Riverbank Laboratories (F. W. Kranz) are instruments using simple tones that cover a wide and continuous range, giving a variation of amplitude for the various pitches. The Western Electric audiometer (Fletcher) and the foreign audiometers all use single pitches, or a series of steps of single pitches that can be varied as to amplitude. These instruments are excellent for determining the limits of hearing for simple tones, and they actually give a perimetric picture of the hearing, but they cannot test the hearing of speech as satisfactorily as the voice test. This is evident to any examiner who tries to draw conclusions from these tests alone as to what will be the ability to hear the voice in a given case of deafness. Patients hearing the voice well may show great error in the other tests, and the reverse also may be true. The entire reason for these discrepancies or lack of relation is not clear.

It is probable that the voice will never be abandoned as a means of testing the hearing of school children, for the test is obviously the most direct to determine the hearing of speech. Speech hearing is what the teacher is most anxious to determine. Voice tests require no expensive apparatus or equipment, but they do require something harder to obtain, that is, intelligence on the part of the examiner. A knowledge of hearing effects and variables is rather infrequently found. The reports of examiners surveying the hearing of school children show remarkable variety, thus Sexton [20] found 13 per cent deaf, of whom only 3 per cent were aware of any defect, and only one of whom was known to be deaf by his teachers (the number of subjects examined was 575).

In the Philadelphia public schools,[21] the number of exempt children examined was 3,587; those with defective hearing, 49 (1.4 per cent); nonexempt children examined, 1,418; those with defective hearing, 29 (2 per cent). ("Exempt" refers to children whose work is satisfactory.)

In Camdem, N. J., just across the river from Philadelphia, the percentages are entirely different. Defective hearing among 10,130

20. Sexton, quoted by Whipple (footnote 10): Manual of Mental and Physical Tests, p. 252.

21. Smedley, F. W.: Report of the Department of Child-Study and Pedag. Investig. 46th. Ann. Rep. Board of Education, Chicago, 1899-1900, also Report Comm. Education 1902, 1, 1095-1115.

normal and retarded children showed the following: in 8,110 normal children, 3.7 per cent had defective hearing; in 2,020 abnormal children, 5.8 per cent had defective hearing.

Whipple, quoting Young,[22] gives these summaries: W. von Reichard, 1,055 pupils, 22.2 per cent of whom had defective hearing; Weil, Stuttgart, 5,905 scholars, from 10 to 30 per cent with defective hearing; Moure, Bordeaux, 17 per cent; Gelle, Paris, 22 to 25 per cent; Bezold, Munich, 25.8 per cent.[23]

The fault is not with the observations so much as it is with the conclusions. It is true that Sexton found 13 per cent among 575 children and that Bezold found 25 per cent, but these figures mean nothing unless one understands the methods used.

Group Testing with the Voice.—In group testing, the usual desideratum is a quick classification or selection of the partially deaf from those whose hearing is "sufficiently good." The tests that are recommended are of value in proportion to the care in technic. The simplest test may be described as lining up the children in an arc about the examiner. The assembly room or the gymnasium is used, the acoustics being better than in the smaller rooms. A class of ten or fifteen may be examined at one time. They are directed to take places on crosses chalked on the floor; they face the examiner who instructs them carefully and slowly that he is going to test their hearing, that he wants them to pay strict attention to what they hear and that he wants them to do promptly what he asks. The children are then half-faced right or left and ordered to close their eyes and to keep them closed. The examiner is now ready for his tests, which consists in asking the children to do certain simple movements, such as "raise the right hand," "touch your nose," "point toward me." Other similar commands are given. Finally the children are faced about and the opposite ear is tested. Throughout the test the examiner tries to maintain a monotone in his remarks. He may increase his distance from the pupils and by this means he can determine the threshold for the different children; their reactions become less and less sure; they are less prompt and mistakes are made; finally, one by one they cease to respond. It must particularly be remembered that noises are more likely to interfere with speech tests than with other hearing tests that are conducted at closer ranges (example, tuning forks). To offset this, the tests must be conducted in as quiet a room as possible, and in doubtful cases the patients must be retested under the most favorable conditions that can be secured (Whipple). The test is crude, but quick and practical.

Wolf and Andrews both recommend the use of numbers as test words. Wolf's work is in German; Andrews has prepared and tested

22. Whipple, G. M.: Manual Mental and Physical Tests, p. 208-209.
23. Chrisman, O.: The Hearing of Children, Pediatric Society, **2**:397-441, 1893.

English word lists, using numbers. Whipple has used Andrews' method to formulate a test that uses the numbers 1 to 100. These numbers are mixed and set down in ten columns containing ten numbers each. The testing conditions of the room are so set that not over 90 of the 100 test words can be heard correctly by the normal ear. I have used and recommend the following modifications for Whipple's test for group examination:

1. Test stimuli: (*a*) Numbers 1 to 100, are divided into ten columns of ten numbers each, or (*b*) the monosyllables given in the table, and designated as those words appearing as among the first 500 in frequency of use.

2. The pupils are supplied with a ruled pad and a pencil; they are seated in an arc, the radius of which is sufficiently great to make only 90 per cent of the test words audible to the normal ear.

3. The pupils are seated sidewise to the examiner, first with the right ear then with the left toward him.

4. No precaution is taken to stop the untested ear, but the arc of seats is purposely kept away from the walls so as to avoid reflection. The intensity of the testing voice is held within limits that make hearing in the untested ear improbable.

5. Attention is directed ("sharpened") toward promptly writing down the words heard. A dash is to be made for words not understood or not heard distinctly.

6. A test word is spoken by the examiner every three seconds; this gives ample time for observation and record. Fifteen seconds rest is given between each series of ten stimuli. The whole test consumes no more than fifteen minutes for the class.

7. The sheets turned in at the end of the test can quickly be tabulated into ratings according to the percentage of correct answers.

On account of the comparison given by testing a number of pupils at the same time, the test serves as a check both on testing conditions and on normal hearing. In this respect group testing gives more instructive observations than single tests.

Whipple treats his records as follows: If the normal percentage is 70 (correct answers) and the pupil's 60, his acuity is 6/7; if the pupil's be 80, his acuity is 80/70, or supranormal. The author adds this modification: If there are any children in the group who are obviously deaf, their observations are dropped from the computation of the normal percentage of the hearing, otherwise the normal hearing figure is unnaturally reduced.

The foregoing test is recommended as quick, practical and reasonably accurate for use in schools.

A NEW METHOD OF MEASURING SPEECH HEARING QUANTITATIVELY

It has long been obvious that if the speech tests could be controlled as to intensity, it would be possible to grade speech hearing in percentage of normal. With this suggestion in mind, Harvey Fletcher has developed a variation of the phonograph, the voice sounds of which are transferred to an electric circuit. Differing from the usual method of recording disks, this phonograph record is made by lateral rather than by vertical impressions on the grooves; the tones are transmitted from the needle to a telephone circuit having a special diaphragm that is practically free from distortion of speech sounds. The graded variation in the intensity of the sound is accomplished during the manufacture of the record; the speed of the disk is constant. A single receiver is used by the person examined. The record speaks a series of numbers, between each of which is an interval sufficient to allow the numbers heard to be written down. After each five numbers the intensity drops one degree. Knowing the sound intensity for each set of five numbers, it is possible to determine directly the percentage of the patient's hearing by observing where he fails to hear and to record. In using the instrument with a "jack" box, ten or more receivers may be used simultaneously, and as many subjects may thus be tested at one time. In an examination made by Dr. Fletcher and myself at the Glen Mills School, it was possible to run through the test for both ears in ten minutes. This will average one minute to the case if ten cases are tested simultaneously.

When proving normal hearing, the results in this test are instructive. The subjects examined were youths between the ages of 14 and 20; the average age was 16.5 years Comparing speech hearing and interpretation with tone acuity as determined by an audiometer, it was found that in the study of large averages the hearing percentage was identical. This fact was established by the use of identical telephone circuits, identical receivers and identical rheostats. Of course, studied individually there were many subjects who showed better speech interpretation than tone hearing, and the reverse; this did not appear to be dependent on any objective or subjective conditions. All the children appeared to be of equal intelligence and alertness, so much so that they were regarded as a class considerably above the normal set of the instruments.

It was satisfactory to note that the test was simple, rapid and free from any confusions or uncertainties to the subjects. The children could easily understand what was wanted and had sufficient time to write down their numbers.[24]

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24. This test, performed at the Glen Mills School, was the first test of the phonograph-audiometer; it has subsequently been used extensively by Bok (Rochester), Newhart (Minneapolis) and others. Credit should be given to Sohier Bryant for the first adaptation of the phonograph to the testing of speech hearing. Singularly, his excellent idea remained unnoticed.

In the use of this method, as with the use of any telephonic method, the criticism may arise that the subjects hear by bone conduction because the receiver is held close to the ear. The objection is theoretic rather than practical, for it is well known by those familiar with the audoimeters which have ear phones that the sounds produced are transverse and not longitudinal vibrations, and thus are capable of but little transmission through bone. It is one of the great shortcomings of the audiometers that no satisfactory method of testing bone conduction has been developed for use with these instruments. In the person with normal hearing, with the receiver pressed hard against the mastoid and with the external auditory meatus plugged, it is necessary to use an intensity equivalent to that required to overcome a 70 per cent deafness before the receiver tones are transmitted by bone conduction.

CONCLUSIONS

In conclusion, so many variables in the voice test have been cited that it seems that its merits must be overshadowed by its faults. The chief difficulty is in the inability to produce a dependable, standard and ponderable stimulus by voice. This is impossible, as the voice is a complex of pitches and amplitudes; thus a complex of intensities.

As a test instrument, the voice is limited to the field of 300 to 3,000 double vibrations, and the pathologic changes of hearing, so far as deafness is concerned, lie most demonstrably at hearing limits above and below this field. Other tests are better for determining the degree of deafness at the upper and lower extremes of hearing.

To obtain results of any value with the voice tests, the greatest care in technic must be exercised. This care is more important with the voice test than with any other hearing test.

It cannot be said that the test is of any great quantitative value in determining the degree of deafness, nor is it of great value in distinguishing the type of deafness, for the stimulus is uncontrollable, undependable and imponderable.

As it is impossible to fix a standard voice stimulus, it is obviously unsatisfactory to report results in terms of hearing distance. The examiner himself cannot repeat identical conditions, (particularly as to voice intensity) on successive testings. No two examiners will obtain identical results. However, if voice hearing is to be reported as to distance heard, it is imperative that the normal hearing distance be noted for the stimulus used.

When testing the more simple sensory phenomena of hearing, it is most important to use care in recognizing, in valuing, in excluding, in minimizing and in standardizing the higher mental factors such as attention, alertness, anticipation, ardor, distraction, indifference, fatigue, memory, training and general intelligence.

With care in technic, the voice test can be put to its greatest use in testing speech interpretation. In this case it must be used at the interpretation threshold where hearing begins to become distinct.

It is reasonable to retain the test in spite of its variables, for as speech hearing is the most important function of the ear, and as the voice test uses as its hearing stimulus the very thing which is most important to test, one is dealing with a direct method. Other auditory tests cannot test speech hearing as well, for they can but test simple, single auditory qualities. The voice test then would seem to resolve itself into a rough test for speech hearing distance, and into the most valuable test for speech interpretation.

1805 Chestnut Street.

PUNCTURE OF THE ROUND WINDOW MEMBRANE

EXPERIMENTS ON THE SACCUS ENDOLYMPHATICUS IN THE RABBIT *

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MONTREAL

The experiments [1] reported here were carried out in an attempt to localize the labyrinthine tonic influence to some particular part of the labyrinth. A more detailed report of some of the experiments will appear in *Pflüger's Archiv für die gesamte Psychologie,* 1926; here I wish especially to report some interesting points with practical bearing which arose in the course of this work.

It has been shown by Magnus [2] and de Kleijn [3] that the well-known diminution of tonus following unilateral labyrinthectomy is composed of two factors: the one permanent, which is a tonic-neck reflex evoked by the turning of the head; the other a passing influence of labyrinthine origin, which is still present after the turning of the head is corrected. They also showed that the latter diminution of tonus does not occur following the injection of cocaine in one labyrinth in the guinea-pig. Arndts [4] has shown that this diminution of tonus is present in the homolateral limbs after section of one of the eighth nerves in the rabbit. He also found that a diminution of tonus occurred in the homolateral limbs following the puncture of the membrane of one of the round windows, and that the tonus in the limbs again became symmetrical after puncturing the round window membrane of the opposite side. This diminution of tonus did not occur when he merely injured the mucous membrane on the medial wall of the middle ear, showing that it was not brought about by any step in the operation previous to the puncturing of this membrane.

It was decided, on the suggestion of Prof. R. Magnus, to carry out a series of experiments in which the round window membrane would be

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1. These experiments were performed in the Pharmacological Laboratory, Rijks University, Utrecht, Holland.

2. Magnus, R.: J. Laryngol. & Otol. **39**:677 (Dec.) 1924; Körperstellung, Berlin, 1924.

3. Dusser de Barenne, J. G., and de Kleijn, A.: Graefe's Arch. **3**:374, 1923. De Kleijn, A.: J. Laryngol. & Otol. **38**:646 (Dec.) 1923.

4. Arndts, Fritz: Arch. f. d. ges Physiol. **212**:204, 1926.

punctured without any direct injury to the membranous labyrinth, and to carry out histologic investigations in the most favorable cases. Dr. A. de Burlet of the anatomic department, Rijks University, Utrecht, is responsible for the direction and the greater part of the work in the histologic investigation; he has given in a report of several of the specimens that had not been received when I left Holland.

By diminution of tonus is meant a difference of tone in the limbs of the right and the left side, the limb homolateral to the operation showing less tone than the cross limbs. This diminution of tonus is best brought out by placing the rabbit in the supine position on the rabbit-board, the head being held in its normal, symmetrical relation to the body, with the chin extended. All external conditions likely to affect the position of the animal should as far as possible be kept the same for all examinations.

TECHNIC

The rabbit was the only animal used in this series of experiments. The middle ear was opened from the inferior surface, the skin incision being made just medial to the angle of the jaw. It was not found necessary to clamp the carotids during the operation. The bulla was opened freely and the nitch of the round window was identified; then under the dissecting microscope, the round window membrane was punctured. The needle was introduced in an antero-inferior direction at the inferior edge of the round window, this being the region where the membranous labyrinth is least likely to be injured. In five of the nine cases, a specially curved needle was used to puncture the membrane, and in four of the cases a fine electrocautery was used instead of the needle.

Before the operation the animals were carefully examined to make sure that the tonus of the limbs was symmetrical and that all reflexes were normal. After the operation, the animals were examined systematically at least once a day. A complete description of the labyrinthine reflexes has been given in English by Tweedie,[5] de Kleijn [3] and Magnus.[2]

Positive proof that the membrane had been punctured was established when clear fluid was seen flowing out from the round window and collecting in the middle ear. This was definitely observed in seven of the cases; in one case it was inadvertently not noted, and in the ninth case several attempts were made to puncture the membrane on successive days, but no fluid could be seen escaping.

The only symptom which could be detected following the operation was a diminution of tonus in the homolateral limbs, and in six of the cases in which clear fluid was seen escaping, the diminution of tonus appeared within six hours after operation. In the seventh case, the diminution of tonus did not appear for four days; then it remained for only four days, when the tonus in the limbs again became symmetrical. The important feature is that all the other known labyrinthine reflexes were normal, except that in three of the cases in which the technic at operation had been faulty, a slight turning of the head appeared when the animal was held in the head-down position (rabbits 1, 3 and 5).

HISTOLOGY

In rabbits 1, 3 and 5, histologic investigation was not made because the technic at operation was not perfect. The report on rabbit 9 has

5. Tweedie, A. R.: J. Laryngol. & Otol. **37**:213 (May) 1922.

not yet been received from Dr. de Burlet. Specimens from rabbits 2, 3 and 8 were broken in the attempt to decalcify them rapidly, but there was sufficient evidence to show that the epithelium of the maculae and cristae was intact, and that there was no gross bleeding or infection in the labyrinth.

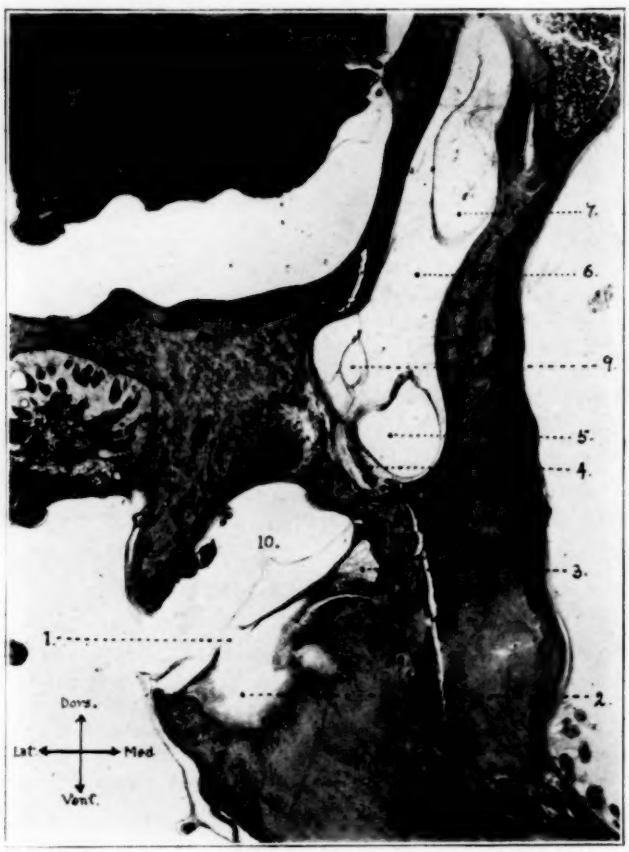

Fig. 1.—Frontal section through the right ear of rabbit 7, showing the rupture in the round window membrane: *1*, the perforation in the round window membrane; *2*, the scala tympani; *3*, the aqueductus cochlae; *4*, the nerve to the posterior ampulla; *5*, the posterior ampulla; *6*, perilymphatic space; *7*, crus communi; *8*, cerebellum; *9*, horizontal semicircular canal, and *10*, niche of the round window.

In the specimen from rabbit 2, there was microscopic blood in the perilymphatic space on the dorsal surface of the utricle. The outer wall of the saccule was collapsed. Reisner's membrane was collapsed in the middle coil of the cochlea. The round window membrane was punctured. The epithelium of the maculae and cristae and of Corti's

organ was normal in appearance. (The slides were frontal sections so that both ears were in the slide and a comparison between the side operated on and the side not operated on could be made.)

In the specimen from rabbit 3, the puncture in the round window membrane could not be made out though there was a little blood just inside the round window on the floor of the scala tympani. The epithelium of the maculae, cristae and of Corti's organ was normal.

In the specimen from rabbit 6 (the animal lived for twenty-four days), only a thickening of the round window membrane was seen. The perforation had evidently closed. All the membranous structures were perfectly intact.

In rabbit 7, the electrocautery had been used for the puncture, and this specimen showed the superior part of the labyrinth, consisting of the utricle and the semicircular canals, as being perfectly normal. In the inferior part of the labyrinth, the outer wall of the saccule was slightly collapsed. There was a chemical change in the endolymph shown by the fact that it stained more pinkish with eosin. This was probably brought about by the heat of the cautery. The ductus cochlearis was not intact at the entrance of the ductus reuniens Henseni. Part of the organ of Corti was lacking. The perforation in the round window membrane is distinctly seen in figure 1. There were fibrous filaments connecting Reisner's membrane to the stria vascularis. As the cautery was used in this case, it might explain much of the injury which was still so light as not to have any effect on the labyrinthine reflexes.

In the specimen from rabbit 8, the electrocautery had been used and the puncture was seen in the round window membrane. As far as seen, the epithelium of the maculae, of the cristae and of Corti's organ was normal.

No attempt was made to examine the hearing of these animals as this would be a study sufficient for a separate research. However, as was suggested by de Burlet, if it is recalled that there was some injury to Reisner's membrane in the specimens from rabbits 2 and 7, it can be appreciated that the mere removal of perilymphatic fluid, no matter how carefully done, may injure the cochlear apparatus and interfere with hearing. This is a practical point when we realize that it is advocated that by puncturing the round window membrane in the human subject gradual relief of intralabyrinthine pressure is afforded; also, a gradual relief of intracranial pressure, by allowing drainage through the aqueductus cochlea. Biehl [6] in reporting a case, does not give in detail the results of examination of the hearing, but mentions that the patient was deaf after the operation, although the hearing later improved.

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6. Biehl, C.: Acta oto-laryngol. **8**:70, 1925; Verhandl. d. ges. deutsch. Hals-, Nasen- u. Ohrenärzte, 1921, p. 242; J. Laryngol. & Otol. **41**:637 (Oct.) 1926.

SUMMARY

Following puncture of the round window membrane, there was no marked disturbance in the vestibular reactions of the animals. They jumped and ran about normally. The only symptom which appeared in all the cases was a diminution of the tonus of the homolateral limbs when the animal was placed in the supine position with the head held in the midline of the body. In five of the nine cases, the diminution of tonus appeared within six hours after operation and in two of the remaining cases, in which the operation had been performed late in the evening, the tonus diminution was definite in the morning. The turning of the head when held in the head-down position that occurred late in three of the experiments was probably due to faulty technic at operation.

From the histologic investigations it was impossible to discover any injury to the maculae or cristae that would explain the diminution of tonus that follows removal of the perilymphatic fluid. These facts led to the belief that the tonus diminution might be brought about by the influence of some outlying part of the labyrinth. For this reason it was decided to investigate the saccus endolymphaticus to determine what part it played, if any, in the production of the tonus diminution in the limbs.

Portmann [7] found a marked disturbance of equilibrium following cauterization of the porus endolymphaticus in the selacean *Leiobatis pastinaca*. His object was to obliterate the saccus. It must be pointed out that in the selacean the endolymphatic system opens on the surface of the head, so that the endolymph is normally in free communication with the surrounding medium, the sea water; but, as is shown in the photomicrographs accompanying his article, the ductus endolymphaticus was sealed by the cautery, which interrupted this communication. These fundamentally different anatomic details make it difficult to compare these results with those which follow interference with the mammalian saccus endolymphaticus. I have been unable to find described in the literature any other experimental work on the saccus endolymphaticus. The function of the saccus is not discussed in the most recent standard textbooks on the physiology of the ear, by Alexander [8] (1924), or by Bethe [9] (1926). Many theories have been put forth from time to time but they are unaccompanied by any experimental evidence.

A study was made of a histologic series of sections of the rabbit's labyrinth and it was found that the saccus endolymphaticus, in part, overlies the lateral sinus and is covered on its medial surface by dura

7. Portmann, Georges: Compt. rend. Soc. de biol. **85**:1070, 1921.

8. Alexander, G., and Marbourg, O.: Handbuch der Neurologie des Ohres, Berlin, 1924, vol. 1.

9. Bethe: Handbuch der normalen und Pathologischen Physiologie, Berlin, 1926, vol. 2.

mater only. In a fresh specimen of the rabbit's head, it was noted that the area of the saccus is about 2 mm. behind and above the opening in the petrous bone for the lobulus petrosus or flocculus, and that the saccus area may be reached through a small trephine opening (4 mm. wide) over the vermis of the cerebellum. The area of the saccus can be recognized by the fact that the dura mater over it is grayish in contrast to the dark colored lateral sinus. Through an opening in the saccus a bristle was passed into the ductus endolymphaticus so that when the bulla was opened and the stapes was removed, the bristle could be seen in the vestibule of the internal ear. The exposure of the saccus was attempted in the living animal, and it was found that by adjusting the

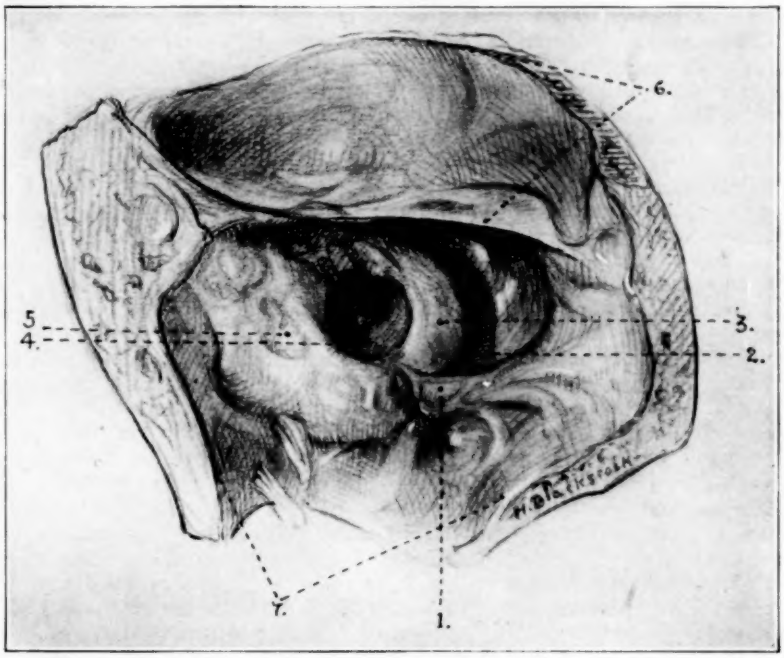

Fig. 2.—Saggital section through the posterior fossa of the rabbit's skull, showing the posteromedial surface of the petrous bone: *1*, saccus endolymphaticus; *2*, lateral sinus; *3*, arch of the posterior vertical semicircular canal; *4*, opening in the petrous bone for the lobulus petrosus; *5*, internal auditory meatus; *6*, middle fossa, and *7*, posterior fossa.

posture of the head the cerebellum would fall away sufficiently to give free access to the saccus region without the use of any retractor or spatula on the brain substance. Ether anesthesia was used, and both carotids were temporarily clamped during the operation. A thorough examination of the reflexes was made before and after operation, every effort being made to detect the slightest change that might occur.

In a rabbit from which both cerebral hemispheres had been removed, the saccus endolymphaticus was exposed on each side; then, under the dissecting microscope each saccus was submitted to probing and pressure. Meanwhile the animal was carefully watched and examined by Professor Magnus, who was unable to detect any effect on the eyes or on the limbs. The result of the manipulation was absolutely negative.

It was then decided to attempt three sets of experiments: (1) incision of the medial wall of the saccus endolymphaticus; (2) the application of continuous pressure over the saccus, and (3) cauterization of the saccus.

THREE TYPES OF EXPERIMENTS

Incision of the Medial Wall of the Saccus Endolymphaticus.—In the first set, there were five successful experiments. An incision was made in the medial wall of the saccus, producing a flap which gave a free opening to the ductus and saccus endolymphaticus. Owing to the presence of cerebrospinal fluid, it was impossible to see whether endolymph escaped from the saccus after the incision.

Immediately after operation, the animals were perfectly normal. They jumped and ran about normally. There was no spontaneous nystagmus of the head or eyes. There were no rolling movements. In three of the cases in which the responses to the caloric and rotation tests were accurately measured before the operation, they were found to be quite the same after the operation and they remained so throughout the experiment. In four of the cases, a diminution of tonus in the homolateral limbs appeared after twenty-four hours and remained constantly present, in the longest case for seventeen days. In the fifth case, a diminution of tonus in the homolateral limbs appeared after six hours. In this case, the opposite saccus endolymphaticus was incised, and after nine hours the tonus in the limbs again became symmetrical.

In three of the cases, a slight horizontal deviation of the eye occurred on the side on which the operation was performed and lasted from one to six days.[10]

The Application of Continuous Pressure Over the Saccus Endolymphaticus.—In the second set of experiments, two were successful. The first was an experiment of short duration. The right saccus endolymphaticus was exposed in the manner previously described, and a metal clamp was fixed over the area of the right saccus and left in position, and the skin wound was closed. The animal was apparently normal, but two hours later a diminution of tonus in the homolateral limbs appeared, lasted for sixteen hours and passed off. There was no spontaneous deviation of the eyes. All other labyrinthine reflexes were normal. Postmortem examination showed the area of the saccus macerated. It was thought that possibly the saccus had been ruptured, which would account for the diminution of tonus in the homolateral limbs; but no such rupture could be detected on histologic investigation.

The second experiment was continued for thirty days. In this case the clamp used was covered with rubber to distribute the pressure more evenly over the area of the saccus. No change from the normal could be detected in any of the labyrinthine reflexes before operation. The animal was normal in every respect. Postmortem examination showed the clamp to be in position over the area of the right saccus and to be compressing the whole area, causing

10. I have given a more detailed protocol in: J. Laryng. & Otol. **41**:349 (June) 1926.

a depression. The saccus was compressed down onto the yielding lateral sinus. It was expected that applying pressure to the saccus endolymphaticus might cause an increase of the tonus in the homolateral limbs, but this certainly did not occur. These experiments do not support the supposition that the saccus endolymphaticus conveys any change of intracranial pressure to the labyrinth.

Cauterization of the Saccus Endolymphaticus.—In the third set of experiments, there is only one case to report, for when a cautery is used to destroy the saccus it is difficult to avoid rupturing the lateral sinus. In this case, the postmortem examination with the dissecting microscope showed that the area of the right saccus endolymphaticus had been thoroughly destroyed down to the wall of the lateral sinus, i. e., to the point where the saccus emerges subdurally from between the sinus and the petrosum. For the first thirty-six hours after operation, the animal showed no change in the normal labyrinthine reflexes; it was to all intents normal; then, about forty-eight hours after operation, a diminution of tonus in the homolateral limbs appeared and lasted till the animal was killed, twelve hours later. It might be pointed out that unless the ductus endolymphaticus was sealed by the cautery, the case would be similar to an incision of the saccus as far as the diminution of the tonus in the limbs is concerned.[11]

SUMMARY

In surveying the results of these experiments, one is struck by the fact that the rabbit shows little disturbance of its vestibular mechanism following incision, cauterization, application of pressure to one saccus endolymphaticus or following the puncture of the round window membrane. To a casual observer, the animal is normal.

The most constant disturbance was the diminution of tonus in the homolateral limbs. In the last group of experiments, it appeared after twenty-four hours in the majority of the cases, in marked contrast to the diminution of tonus which followed puncture of the round window membrane and which, in the majority of the cases, appeared within six hours. This late appearance of the diminution of tonus would indicate that this phenomenon is not brought about by interference with a possible receptor organ situated in the saccus endolymphaticus. When the saccus was cauterized any such receptor organ should have been destroyed, yet in this animal the tonus diminution did not appear for forty-eight hours after the operation. Again, it would seem unlikely that the saccus endolymphaticus is directly concerned with the diminution of tonus which appears immediately after the round window membrane is punctured. The delayed appearance of the diminution of tonus in the homolateral limbs from incision of the saccus would seem to indicate that as the endolymph slowly escaped through the wound in the saccus, some part of the labyrinth is affected which is more immediately disturbed following the sudden release of the perilymph by puncture of the round window membrane.

11. The histologic reports from the specimens of the last two sets of experiments have not yet been received from Dr. de Burlet.

The only other symptom suggestive of labyrinthine disturbance was the horizontal deviation of the eyes to the side of the operated saccus endolymphaticus. This symptom was always slight; it was present in only three cases, and it was transitory, so that so far it has been impossible to draw any conclusions from this symptom.

CONCLUSIONS

Following puncture of the round window membrane with release of the perilymphatic fluid, the rabbit showed little disturbance of its vestibular mechanism, and was able to jump normally.

In the majority of cases following puncture of the round window membrane, there was a diminution of tonus in the homolateral limbs which appeared early—within six hours—and lasted in the longest case for eleven days, when the animal was killed.

When the operation is carefully performed, all other labyrinthine reflexes, except the tonus diminution in the homolateral limbs, are normal.

In the rabbit there is no marked disturbance of motor function or of equilibrium following incision, or cauterization, or the application of continuous pressure to the saccus endolymphaticus.

Opening of the saccus endolymphaticus was followed by a homolateral diminution of tonus in the limbs which in the majority of cases appears late—after twenty-four hours.

The saccus endolymphaticus is not, as far as these experiments show, the seat of a receptor organ which has control over the tonus of the limbs, and it is probably not the immediate cause of the diminution of tonus which appears in the homolateral limbs after the round window membrane is punctured.

The labyrinth of the rabbit was not appreciably affected by a slight increase of the pressure on the saccus from the dural surface.

The labyrinthine reflexes (excepting the tonus of the limbs) were not interfered with, even after total ablation of the saccus endolymphaticus by the cautery.

MASTOID INFECTIONS IN INFANTS*

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ST. LOUIS

Prior to the last few years, a mastoiditis requiring operation was rarely diagnosed in infants except on the basis of external signs: redness, swelling or subperiosteal abscess. It is now known that an infant may have a severe mastoid infection, capable of producing profound constitutional symptoms and even death, without the presence of any of the external signs.[1] In adults, one of the most dangerous types of mastoiditis runs its entire course, often leading to serious intracranial or constitutional complications and death, without presenting any external evidence of the disease. This has been called the hemorrhagic type of mastoiditis because the local dissemination of the infection takes place by way of the blood vessels instead of by contiguity, as in the coalescent type of the disease. Each of these types of mastoid infection has its analog in the infant, differing from the adult condition only because of the anatomic difference between the adult and the infantile temporal bone.

The tympanic cavity and ossicles of the new-born child are practically the same as those of the adult in size and shape, with the difference, however, that in the baby the entire upper part of the cavity is filled with soft myxomatous tissue folds which prevent direct communication between the hypotympanum and the aditus ad antrum. This mucosa when infected is subject to rapid purulent transformation, so that epitympanic suppurations are more common in infants than in adults, and adequate drainage of this portion of the ear cavity by myringotomy is more difficult to maintain.

The eustachian tube of the infant is relatively shorter and more horizontal in position than that of the adult, and its lumen is larger. These differences furnish the explanation for the fact that an infant may have a tympanic cavity full of purulent secretion and yet inspection of the drum may reveal neither redness nor bulging. Both of these symptoms, which are practically always found in the presence of an acute suppuration of the ear in the adult, are the results of pressure. In the baby, however, the pressure in the middle ear is relieved by spontaneous drainage of the abscess in the ear through the relatively larger and shorter eustachian tube. Alexander[2] states that

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1. Alden, A. M., and Lyman, H. W.: Gastro-Intestinal Disturbances in Infants as a Result of Obscure Infection in the Mastoid, Laryngoscope **35**:586-591 (Aug.) 1925.

2. Alexander, G.: Diseases of the Ear in Infancy and Childhood, J. B. Lippincott Company, 1917, p. 161.

the tympanic membrane of the new-born infant is thicker and more resistant than that of the adult, and gives this as one of the reasons for the length of time often required for the ear drum of a baby to rupture spontaneously in a suppuration of the middle ear.

My own experience would lead me to doubt this statement. I believe that the failure of the infant's drum to rupture is more often due to the release of pressure by the evacuation of the purulent contents of the middle ear by way of the eustachian tube. This observation has some confirmation in the fact that, by means of the nasopharyngoscope, a stream of pus coming from the pharyngeal orifice of the tube has been observed in several babies whose ear drums were intact, showed no bulge or redness, and in which incision revealed free pus in the tympanic cavity.

The type of mastoiditis in infants that gives rise to a subperiosteal abscess is a distinct and characteristic clinical entity. It usually rapidly follows a typical acute suppurative otitis media and is accompanied by pain, some fever and, as a rule, a low leukocytosis. Severe constitutional symptoms are rare in this form of the disease, although occasionally a moderate amount of toxemia is present until the abscess ruptures through the cortex. With the appearance of the external signs, the fever, pain and constitutional manifestations subside rapidly, and it is not uncommon to see a child with a tremendous subperiosteal abscess of several days' duration with no pain, fever or other discomfort accompanying it. Following operation these patients almost without exception have a rapid and uncomplicated convalescence, and usually the functional return of the ear to normal is complete.

The pathologic condition in this form of the disease is in every way analogous to the coalescent mastoiditis of adults. The infection of the middle ear through the partly open tube and the involvement of the mesodermal folds in the epitympanic cavity and mastoid antrum with partial liquefaction, swelling and obstruction in the narrow aditus are rapidly followed by an increase of pressure in the mastoid antrum, with capillary thrombosis, death of bone cells and rupture in the line of least resistance, which is usually the thin lateral wall of the antrum. During the stage of pressure, pain, fever and malaise are present, but with the external perforation through the bony cortex and the release of the pressure, the subjective symptoms, as a rule, subside promptly.

Until the last few years, this has been considered the typical clinical picture of mastoiditis in an infant, and in cases in which the principal objective features of this syndrome have been absent, a diagnosis of mastoid infection has only rarely been made.

Largely as a result of postmortem examinations on infants who had died of gastro-intestinal disease, it has been learned that there is a type of mastoid infection in the baby that is apparent only to the trained

observer because in most of the cases none of these objective features of the disease are present. The only signs that are of otologic significance are the changed color of the drum and a distinct downward sag of the superior canal wall just external to the annulus. In this form of the disease, the constitutional evidences of absorption are the predominating clinical features. This syndrome in a baby has commonly been called "cholera infantum," and is abrupt in onset, usually requiring early and vigorous supportive measures to prevent a fatal termination before the source of the infection can be ascertained and removed.

Jeans [3] describes the pediatric features of this condition by saying:

> The symptoms in general consist of a marked and rapid loss of weight, fever, diarrhea, dehydration and the appearance of intoxication. The intoxication is characterized by drowsiness or stupor and pallor with a grayish hue; it may appear simultaneously with the fever or follow it in a few hours. The temperature curve is inconstant. When fever existed previously, a secondary increase may occur. Diarrhea usually parallels and coincides with the dehydration and weight loss. Sometimes the onset of diarrhea is slightly delayed, and in a few otherwise typical cases diarrhea has been absent. Usually there are from eight to twenty mucus-containing, foul smelling stools daily. The dehydration is reflected in the weight loss and the loss of skin elasticity: it is sometimes of such a marked degree as to cause the appearance of extreme emaciation. Prior to the establishment of drainage from the site of infection, parenterally administered fluid is often reflected in an increase in the diarrhea. The leukocyte count has varied from 13,000 to 30,000 or more. Vomiting may occur throughout the course of the illness, with varying degrees of severity. Refusal of food is a fairly constant feature. Marked degrees of acidosis, as measured by the carbon dioxide combining power of the plasma, have been noted. The urine may at times contain casts and slight amounts of albumin; glucose has not been found.

The pathologic condition in this type of the infection is not due to pressure but to a rapid and massive absorption of toxic products which act on the mucosa of the gastro-intestinal tract of the infant, probably by damage to the capillaries.[4] Owing to the fact that the bony elements which later go to make up the temporal bone are only loosely connected in the infant, the absorptive properties of the infantile middle ear are unquestionably greater than those of the adult. The fact that in thirty-five cases of subperiosteal abscess in infants coming to operation at the St. Louis Children's Hospital during the last six years, the majority of the cultures showed a staphylococcus or nonhemolytic streptococcus, while the cultures from the ears of thirty-two infants with the other form of the disease almost without exception contained a hemolytic streptococcus, would suggest that a certain bacterial specificity for each form of the disease may exist.

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3. Jeans, P. C., and Floyd, M. L.: Upper Respiratory Infection as a Cause of Cholera Infantum, J. A. M. A. **87**:220-223 (July 24) 1926.

4. Marriott, W. M.: Observations Concerning the Nature of Nutritional Disturbances, read before the American Pediatric Society, Washington, D. C., May 5, 1925.

The chief reason for the failure in the past of otologists to recognize this type of infection in the infant has been that these patients are always first seen by the pediatrician, who, if he does not appreciate the intimate connection that often exists in the infant between obscure ear infection and gastro-intestinal disease, fails to call the otologist into consultation. Marriott,[4] Jeans and Floyd [3] and others have repeatedly called attention in pediatric literature to this association, and each year more of these patients are seen; previously practically all died. Proper recognition by pediatricians of the significance of this disease combination in the infant and closer study by otologists of infections in the infantile ear will in a few years result in an understanding of the pathology and treatment, and perhaps the prophylaxis of this condition, which will be a material factor in the reduction of infant mortality.

THE DIAGNOSIS OF SINUS THROMBOSIS

A NEW PROCEDURE *

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NEW YORK

If in simultaneous blood cultures taken from the two internal jugular veins a larger number of bacteria were found in the plates made from one side than in those made from the other side, it might be inferred that the bacteria in the blood were coming from that side. One might expect such a procedure to be valuable not only in confirming a diagnosis of thrombosis of the lateral sinus but also in determining the side involved. In the first case in which I had the opportunity to test this method, a culture from the internal jugular vein was negative, and the patient subsequently recovered without operation. In the second case, the result was surprising.

REPORT OF CASE

A boy, aged 7 years, was admitted to the pediatric service of Dr. Bela Schick, Feb. 4, 1926, complaining of pain in the left thigh and fever. Three weeks before admission to the hospital, he had suffered from a bilateral otitis media, which had apparently subsided. For two weeks before admission, he had had an elevated temperature, at times reaching 104 or 105 F.; at other times the temperature was normal for as long as two days. During the patient's stay in the hospital, the temperature had been high and irregular.

Physical examination showed anemia, the evidence of a resolving acute purulent otitis media in both ears, with a small, dry perforation of the right drum, a systolic murmur at the apex of the heart, a large firm spleen and liver. A blood culture made, February 8, showed 60 colonies of hemolytic streptococci per cubic centimeter of blood, and one made, February 10, 120 colonies per cubic centimeter of blood. On account of the absence of evidence of mastoiditis, and because there was doubt as to the nature of the infection, Dr. Isidore Friesner, the otologist in charge, preferred to postpone operation, although he though there might possibly be a primary thrombosis of the jugular bulb.

On February 12, blood cultures were made from both internal jugular veins in the following manner: With the child on an operating table inclined at an angle of about 45 degrees (Trendelenburg position), so that the head was low and the veins of the neck distended, exactly 4 cc. of blood was removed with a Record syringe, first from the right and then from the left internal jugular vein. About ten minutes elapsed between punctures. The same syringe was resterilized and was used both times.

Two cubic centimeters from each vein was placed on a plate in glucose ascites agar and 2 cc. in plain ascites agar. At twelve hours, the glucose plate from the right side showed more than 600 colonies. At this times, both plates from the left side and the plain plate from the right showed no colonies. At thirty-six hours, the two plates from the left side showed 18 and 17 colonies of hemolytic streptococci, respectively. The plain plate from the right side

* From the Pathological Laboratory, Mount Sinai Hospital.

showed 556 colonies (or 278 colonies per cubic centimeter of blood). At this time, the colonies in the glucose plate from the right side were uncountable because of the heavy precipitate that had formed.

On February 14, Dr. Friesner saw the patient again and decided to have an exploratory operation performed on both sides. Both mastoid processes were found normal by Dr. J. L. Maybaum, who performed the operation. The right lateral sinus was normal. The left lateral sinus showed an extensive thrombosis extending down into the left jugular bulb and farther back in the lateral sinus than it could be followed. The left internal jugular vein was ligated. The boy subsequently made an uneventful recovery.

It is possible to explain the bacteriologic observations, although they were surprising and at first apparently contradictory. There are two possibilities: (1) Bacteria may have been growing in preponderating numbers or exclusively in the upper end of the thrombus, or (2) approximately equal numbers of bacteria may have been growing at both ends of the thrombus. In general, the second explanation is more probable. The upper part of the internal jugular vein on the thrombosed left side must have been a long culdesac with no tributaries; therefore, after the occlusion of the internal jugular bulb, the blood in it should have been relatively stagnant. Since the normal exit was blocked, any current in the left lateral sinus must have been reversed, and would have found its way out through the communication at the torcular herophili into the right lateral sinus. The right internal jugular vein would of necessity have carried practically all of the blood from the brain and meninges, including any bacteria derived from the left lateral sinus; this explains the presence of the larger number of bacteria on the normal side.

Thus it appears probable that if one were dealing with a mural, nonobstructive thrombus, one would get a diametrically opposite result from that found in this case of an occlusive thrombus: the greater number of bacteria would be on the affected side. For this reason, the usefulness of the procedure for determining on which side the thrombus lies probably will be limited.

In a third case, in which the procedure of double internal jugular blood cultures was tried, these cultures (unfortunately, only one plate from the right and two plates from the left vein) were negative; a routine blood culture (four plates and two flasks) taken from the vein in the arm also was negative. Ten days later, another routine blood culture (four plates and two flasks) gave a streptococcus in one bouillon flask only. On the following day, operation revealed a thrombus in the left lateral sinus.

In cases like this, in which only a few bacteria are given off by the infected thrombus, and in which, on account of dilution by the remaining body blood, bactericidal action of the blood and filtration of bacteria by the tissues, so few bacteria are present in the periphery as to elude detection by the ordinary blood culture methods, there is a possibility that the new procedure will give a positive result; but it will be necessary to

take blood not only for agar plates but also for fluid mediums (in which an occasional organism has a better chance for growth).

TECHNIC OF ASPIRATION

As to the technic of aspiration from the internal jugular vein, the procedure is exceedingly simple, and, if carefully carried out, I believe, entirely without danger. In infants and persons with arm veins from which it is hard to take blood, the internal jugular is probably the easiest vein in the body from which to secure blood. The operator should stand at the head of the table. A small, sharp needle (1½ inch length, 19 gage) is inserted at about the level of the hyoid bone in the anterior third of the sternomastoid muscle, and is pushed downward and inward toward the manubrium so as to pierce the sternomastoid muscle obliquely. The internal jugular vein is superficial, being covered by only the anterior part of this muscle. An adult is instructed to hold his breath and press in order to distend the vein. Children usually cry, and this accomplishes the same purpose. Various compression devices at the base of the neck have been tried, but none has seemed to work as well as the method described. I have performed this procedure twelve times and I have failed to enter the jugular vein with ease only once. This was in a boy who on account of his poor general condition could not be inverted. One patient was an infant, aged 1 year, in whom all attempts to obtain blood from other peripheral veins had failed.

CONCLUSIONS

The fact that there is a difference in the number of bacteria in the blood of the right and of the left internal jugular vein, as obtained by puncture through the skin, is an aid in the study of sinus thrombosis. In future work bouillon flasks, as well as agar plates, should be inoculated, and a simultaneous culture should be taken from an arm vein. Only further experience can tell whether the observations will be of any help in determining on which side the thrombus lies.

The same principle can possibly be applied to certain other forms of infections; thus, for example, an osteomyelitis in the leg causing a blood stream invasion should give larger numbers of bacteria in the corresponding femoral vein than in other peripheral veins.

This article is a preliminary report and is published in order that the method may be tried by others, and that its value, if any, may be determined on a larger amount of material.

Clinical Notes

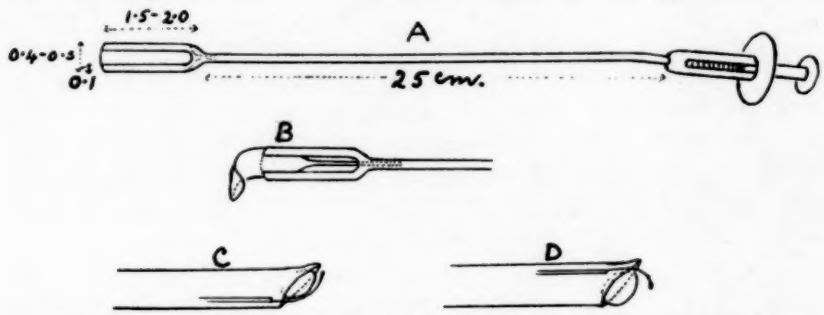
A HOOKLIKE INSTRUMENT FOR THE EXTRACTION OF FOREIGN BODIES FROM THE BRONCHI*

M. Sasaki, M.D., Fukuoka, Japan

It is usually difficult to remove a soft foreign body from the trachea or from the bronchi without breaking it. Various kinds of forceps have been devised, but most of them hamper the field of vision in the narrow passage. If the foreign body is round or soft, there will be a tendency for it to slip away or to be broken when seized with the forceps.

I have constructed a new, hooklike instrument with a view to eliminating these defects as far as possible.

A small, rectangular metal plate is bent up at both sides so as to form shallow furrows or channels and serve as a sheath. Then a thin elastic steel plate is pushed into the sheath, as is shown in *A*. When pressure is applied to the handle of the hooklike instrument, this steel plate is bent by its own elasticity and is pushed out of the sheath, as shown in *B*. The instrument con-



Author's instrument for removing foreign bodies from the bronchi.

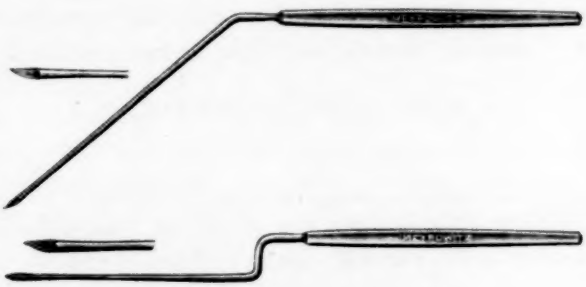
taining the steel plate in the sheath is at first introduced along the inner wall of the tube; then it is advanced along the mucous membrane of the trachea or bronchi and finally to a point a little beyond the foreign body. When the instrument is in this position, the operator pushes the handle, seizes the foreign body with the hook and removes it from the passage. If the foreign body is smaller than the calibre of the tube, it is extracted through the tube. If, however, the width of the tube is smaller than the foreign body, the latter is held fast at the end of the tube and is extracted with the tube (*C*). In *D* is shown a wrong position for the fixation of the foreign body. The instrument has been used in two cases, and the foreign bodies were extracted easily and rapidly. In applying the instrument in these two cases, I noted two peculiarities of the device: (1) as the hooklike instrument is more slender than the forceps, it blocks the field of vision in the passage very slightly, and at the same time it is much easier to remove the foreign body through the tube; (2) the foreign body does not slip nor is it broken when grasped, which shortens the time required for the operation.

*From the University Ear, Nose and Throat Clinic, Fukuoka, Japan; Director, Prof. Dr. Ino Kubo.

A NEW MYRINGOTOMY KNIFE

C. A. Campbell, M.D., Steubenville, O.

This new myringotomy knife has the following advantages: 1. It has a shank of sufficient length to be used with the larger speculums, including the electric otoscopes, especially the Cameron; the shank is 100 mm. long 2. It has a "needle blade" to minimize trauma, of 3 mm., with a "stop" at the junction with the shank. 3. Either the angular or bayonet handle may be selected.



Myringotomy knife.

Progress in Otolaryngology

Summaries of the Bibliographic Material Available in the Field of Otolaryngology

THE FUNCTIONAL EXAMINATION OF HEARING

DEAF-MUTISM AND THE EDUCATION OF THE DEAF ANNUAL REVIEW OF THE LITERATURE *

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There are a number of striking facts in the literature of the last year on the subject of the functional testing of hearing. One is the prominence of American as compared with European authors. Previously the greatest part of the work on this subject usually was done by the Germans and Austrians, but this year the reverse has been true. I believe that this is an encouraging sign, and hope that American and English writers will continue to show an interest in this subject, which is an important one. While it is true, as many assert, that after careful tests have been made therapy is deficient in many cases, I still feel that it is only by making careful examinations and arriving at accurate diagnoses that the indication for treatment, if any, may be found. The prognosis is then known and one is in a position to give the patient and his relatives the best advice regarding the future care of the patient.

Second, a great deal of attention is being paid to the study of the bone conduction, or as it is now often termed, cranial resonance. Last year I reviewed the original article of Schoen and Goldberger, and this year a large number of articles have appeared on this subject, some of them in this country. While the matter of cranial resonance is not a new one, authors during the last two years have rendered good service in calling attention to and investigating this phenomenon. In a review of this kind, it is impossible to go into much detail without lengthening the article beyond proper proportion. Merely the essentials of these articles on resonance will be given; those who are interested may be stimulated to further reading or original investigation.

Third, audiometers are receiving increasing attention at the hands of many otologists.

* This review includes articles published from November, 1925, to October, 1926. Some of the foreign journals do not arrive in time for the summary of the current year, and so are reviewed during the following year.

DEFINITION OF FACTS OF AUDITION

Jones and Knudsen [1] consider the ear as a physical instrument on which they have made measurements which have brought out certain salient facts of audition. They state that a sound may be classified as either a tone or a noise, a tone being the result of a periodic, and a noise the result of a nonperiodic, wave motion. The external wave motion producing the sound has three distinct properties: amplitude, frequency and wave form. The wave form determines the quality of the sound sensation, the amplitude determines the loudness, and the frequency fixes the pitch. The relation between the stimulus and the cochlear response is not one of simple direct proportion but follows the Weber-Fechner law of psychophysics. The musical interval of pitch, the octave, is produced by two tones whose frequencies have the ratio 1:2. Equal ratios of frequencies produce equal intervals of pitch.

In considering loudness, Jones and Knudsen state that the energy of the wave motion reaching the cochlea must attain a definite minimal level before it can be appreciated. This energy varies greatly for tones of different pitch; the lowest and the highest tones require greater energy than the tones of moderately high pitch. The cochlea is most easily affected by the tones of the frequency range employed in speech. The loudness of the sensation of tone is determined by the amount of energy in the wave motion and the acuity of the hearing of the subject. One of the best methods of testing auditory acuity is the measurement of this minimal threshold of loudness. Such measurements are basic in determining the nature and the degree of the hearing defect. If a tone is carried beyond the upper limit of loudness, it produces a sensation of pain as well as the tactile sensation of feeling, and even a deaf-mute is able to feel such excessive stimulation. In order for one tone to be appreciated as louder than another, the amplitude must be increased at least 5 per cent. A lesion of either the middle or the internal ear has no effect on the capability of the cochlea to differentiate loudness.

The human ear responds to a range of pitch from 20 to 20,000 double vibrations, which embraces a range of ten octaves. The normal cochlea can distinguish about 1,500 gradations of pitch with this range. The pathologic cochlea can perceive differences in pitch as well as the normal cochlea. The normal ear can appreciate 324,000 pure tones, and the number of these tones which can be sensed by a person is a measure of his percentage of hearing.

The quality of a musical tone is determined by the shape of the wave or, in other words, by the number and relative loudness of the overtones which accompany it. If it has no overtone, it is a pure tone.

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1. Jones, I. H., and Knudsen, V. O.: Facts of Audition, Ann. Otol. Rhinol. & Laryng. **34**:1013 (Dec.) 1925.

"Auditory masking" is the obliteration of one tone by another. Masking is useful in tests for malingering, and is one of the useful facts in formulating a plausible theory of hearing.

The two tones differing slightly in pitch, sounded together, produce "beats" which are periodic augmentation and diminution in loudness. The rate is determined by the difference in the vibrations per second of the two tones. If the beats are more frequent than twenty per second, they will be sensed as a musical tone. Each tuning fork produces its own tone and when sounded together, they produce beats which produce another lower tone. Subjective tones are the summation and difference of the original two tones.

The impressions received by one ear may be slightly different from the impressions received by the other. Two ears enable one to locate sound better than one ear, and therefore a person hearing with only one ear is inaccurate in his localization of sound. This may be of advantage in tests for malingering. For the perfect appreciation of speech a person should have approximately normal hearing for limits of pitch between 60 and 6,000 double vibrations, and for music the ear should respond to a tonal range between the limits of about 39 to 16,000 double vibrations. This shows that a person with impaired hearing may be at a greater disadvantage for appreciation of music than for conversational speech.

This article is accompanied by graphs of the upper and the lower limits of pitch and the sensitivity of the ear to loudness.

HARP AND TELEPHONE THEORIES

Knudsen and Jones [2] in another article deal mainly with the theories of response of the cochlea. The question "where we hear" seems to have been answered satisfactorily. The anatomic structure of the cochlea makes it highly probable that it acts as a vibrating structure so that each physical vibration from the external world causes a corresponding vibration within the cochlea. The cochlea then transmits to the brain a corresponding nervous impulse. The difference in opinion arises as to the precise way in which the cochlea works and has resulted practically in the two theories, the harp and telephone theories.

The harp theory is based on the principle of physical resonance. (This was first given practical expression by Helmholtz, although it appears that it had been advanced previously, notably by Perrault, 1680, Duverne, 1683, and Cortugno, 1760. It is usually spoken of as the resonance theory.) The principle of physical resonance is that each vibrating element stands ready to respond to its own appropriate frequency. So for every external wave impulse there is a corresponding

2. Knudsen, V. O., and Jones, J. H.: Auditory Facts and Theories—Theories of Audition, Ann. Otol. Rhinol. & Laryngol. **35**:122 (March) 1926.

pattern of sympathetic vibration within the cochlea. It is still a question as to which structure is the active vibrator, the basilar membrane, the tectorial membrane or a combination of these with the organ of Corti. To explain the auditory masking of tones, the "maximal amplitude" theory, has been presented; according to this theory, perception of pitch is determined by the position of the maximal vibrations of the continuous membrane.

The telephone theory postulates that the entire vibrating membrane of the cochlea responds to every type of vibration from the lowest to the highest frequency, which in turn transforms these physical vibrations into nervous impulses which are then conducted en masse to the brain. The pitch sensation is determined by the frequency of arrival of these impulses at the cerebral cortex. These are various modifications of this theory. One is that vibrations penetrate the cochlea according to their amplitude, the smaller ones a short distance and the larger ones a greater distance. Wrigleton's theory considers each pendular vibration reaching the ear as capable of producing four distinct types of nerve stimulation which accounts for the presence of subjective tones.

Relative Plausibility of the Two Theories.—Arguments in favor of the telephone theory and against the harp theory are:

1. The mechanism (the stapes and cochlear tube) is adapted for gross displacement of the entire membraneous cochlea.

2. The continuity of the cochlear membrane from the base to the apex suggests that the vibrating membrane acts as a diaphragm rather than as individual fibers.

3. The assumption that this continuous membrane vibrates as a whole makes it easier to account for the great damping of tones that occurs within the cochlea.

4. The harp theory is confronted by the fact of the infrequent occurrence of diplacusis and also the extraordinary requirements of the length, tension and mass of the receptors within the cochlea.

Arguments for Harp Theory.—1. The work done by both Partridge and Wilkinson on the basilar membrane, and that done by Shambaugh and also Hardesty on the tectorial membrane, presents plausible evidence that these membranes possess the necessary requisites of length, tension and mass to support the harp theory.

2. The gradations of pitch and loudness can be explained by nature having provided a sufficient number of nerve receptors, namely, the hair cells in the organ of Corti and the nerve filaments in the auditory branch of the eighth nerve to account for the appreciation of all these possible gradations.

3. Certain pathologic evidence, including tonal tinnitus, diplacusis, tonal depressions, invasion of the cochlea by otosclerosis and animal experimentation support the harp theory.

In conclusion, Knudsen and Jones believe that the weight of evidence at the present time is in favor of some type of the harp theory. The most reasonable theory is that of maximal amplitudes which postulates that there is a series of resonators within the cochlea closely coupled so that one cannot act without causing the immediate adjacent structure to participate in the vibration. This theory seems most consistent with the known anatomy, with the continuity of the vibrating structures within the cochlea and with the observed facts of audition, and seems to be the most satisfactory explanation for the familiar pathologic conditions encountered in routine practice.

METHODS OF FLETCHER

Fletcher [3] presents a new single scale with units similar to those used with the audiometer to represent the degree of hearing and the percentage of loss of hearing independent of the tests used. To increase speed and accuracy in making hearing tests, the Bell Telephone Company has devised several pieces of apparatus which include a phonograph type of audiometer which makes records for reproducing the speech sounds, insuring a definite volume of voice for accurate comparison. The recorded speech sounds are transformed into their electrical equivalents and then carried by means of wires to the receiver held to the patient's ear, the intensity of the sound being controlled by the electrical resistance current. This instrument is in three different forms for the testing of individuals, large groups, or as an auxiliary to either the 1A, the 2A or the 3A audiometer; as such the speech intensities can be varied ten billionfold, corresponding to a distance variation of more than 100,000.

Fletcher names four groups of hearing tests which are needed:

1. Industrial, to determine the fitness of a candidate for employment.

2. Educational, to determine the degree of hearing of school children in both the public schools and the schools for the deaf, for the purpose of determining the proper methods to be used in their education.

3. Clinical, or those made for assisting the physician to make a proper diagnosis of the cause of deafness.

4. Research, or tests made to determine new facts about both normal and abnormal hearing.

Fletcher presents several tables and formulas to show how results obtained from the voice test, watch tick, acoumeter, coin click and tuning fork tests can be converted into hearing loss units in the new scale which he presents.

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3. Fletcher, H.: New Methods and Apparatus for Testing Hearing, Ann. Otol. Rhinol. & Laryngol. **35**:165 (March) 1926.

In the January, 1926, issue of the ARCHIVES OF OTOLARYNGOLOGY, I called attention to the work of Fletcher, which is creditable to him, in that he had been of aid to otologists in devising and publishing facts regarding the determination of the "damping constant" of the fork. By means of this "constant" one is able to determine the loss of hearing in sensation units just as with the audiometer, and as Fletcher himself has stated, using a sufficient number of forks supplied with this constant of decrement, it is possible to obtain curves comparable with those procured when using audiometers. However, when a large number of forks are used, the test will require a longer time than with the audiometer; on the other hand, the extra expense of having the "constant" determined for each fork is so small that the cost of the average series of forks required does not approach the cost of an audiometer.

VALUE OF AUDIOGRAPHS

Fowler [4] states that the older methods for testing the ears are still valuable if intelligently used, but that they are inaccurate quantitatively. Several observations made with tuning forks are necessary for the perfect test in order to train the patient and to get the proper conditions for the test. The general opinion seems to be that an expensive audiometer is necessary in order to draw an audiogram of the hearing, but this is not so. Excellent tracings differing only in unimportant details from audiometer tracings may be obtained with the use of carefully calibrated tuning forks without the aid of any electrical apparatus. However, this is laborious in that it requires a number of observations and the necessity of waiting the best part of a minute for the fork to die down to minimum audibility at each trial. The great diagnostic value of accurate audiographs is that they show a complete picture of the hearing capacity over the whole range of frequencies for both ears.

There are frequent exceptions to the standard teaching that obstructive lesions show loss for the low frequencies and nerve lesions for the high, as shown by many graphs. As a result, Fowler states that he is becoming more and more cautious in applying the old dictum.

> From a physical standpoint there is every reason to believe that there can be a loss at any frequency in obstructive lesions, depending upon how these happen to affect the acoustic characteristics of the ear. . . . As a working basis hearing losses are still interpreted at the low and high frequencies and thus we tend to read our audiographs.

Fowler sums up the data and value derived from accurate audiographs as follows:

Many ears believed perfect by the patient show marked defects, especially in the frequencies not used for speech.

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4. Fowler, E. P.: The Clinical Value and Diagnostic Significance of the Newer Tests for Hearing, Laryngoscope **35**:896 (Dec.) 1925.

Many abnormalities of the ears appear to be inherited and no changes may be shown during many years or throughout life. Other members of the same family may have similar abnormalities.

The already developed defects at certain frequencies although unnoticed by the patient may warn the examiner of impending deafness. Sufficient time has not yet elapsed for us to interpret these graphs diagnostically.

Return to normal or near normal is shown with great precision.

Failure to return to normal is most important to note, and treatment may be undertaken which otherwise would not have been deemed reasonable.

Malingering is easily detected because no one can repeatedly sense correctly a given intensity of sound.

To diagnose total deafness in one ear, it is possible to construct as a guide binaural graphs of known instances of nonaural total deafness, and compare with such guiding graphs the curves obtained from suspected totally deaf ears.

When all the data are considered, it is apparent that even normal ears do not show a straight normal line, but vary up and down, depending on time, place, barometer, fatigue and noises.

Fletcher [5] compares audiograms redrawn from the Dean and Bunch curves on the new scale of sensation units with the original curves. They agree fairly well, except in cases of extreme deafness or for high frequencies when the differences seem larger than one would expect. This, he says, may be due to variations in the apparatus, testing technic or in the patient's judgment. He suggests using the damped receiver to decrease the variability of the high frequencies. The principal purpose is to adapt the curves so that the work done with one type of audiometer may be compared with the results obtained with another type.

Bunch [6] compares curves obtained in the various diseases of the ear, such as chronic suppurative otitis media, otosclerosis and deaf-mutism, using both the pitch range and the vacuum tube audiometer. He concludes that "gaps shown by the pitch range audiometer in numerous curves appear only as dips in the 1A audiometer, and narrow gaps do not appear unless the stimulating tone of the 1A audiometer coincides with the gaps." Furthermore, the tones of the pitch range audiometer are too faint to determine absolute deafness, but are loud enough to indicate loss of hearing for voice. The tones of the 1A audiometer are sufficiently intense to produce responses in patients deaf to all other tones. The curves of "serviceable hearing" in the audiograms used

5. Fletcher, Harvey: Comparison of the Results Made with Two Types of Audiometers, Arch. Otolaryng. **4**:51 (July) 1926.

6. Bunch, C. C.: Auditory Acuity Tests: Comparison of the Results Made with Two Types of Audiometers, Arch. Otolaryng. **3**:108 (Feb.) 1926.

for the 1A audiometer are misleading, unless there is an accurate description of the meaning of the term "serviceable." In the present stage of diagnostic knowledge, the curves for both instruments present the evidence with a clarity much greater than is possible with acuity tests made with tuning forks.

The presence of tonal islands, that is, fields of hearing of limited extent, have abundant verification from both types of instruments. Complete gaps have not appeared in those cases in which tests have been made with the 1A audiometer.

Bunch also states,

> Assuming that the resonance theory of hearing is true, if a defect in the resonating membranes of a very limited extent should exist, according to physical laws the defective portion would be made to vibrate and carry with it the adjacent nondefective portions of this membrane if sufficient power is applied. The defect would appear only as a dip in a hearing curve. This may be the cause of the nonappearance of the gaps in the 1A curves since the tones from this instrument are extremely intense. The question can possibly be solved by studies in diplacusis and in variations in pitch discrimination between the two ears.

Nemzel and Hays [7] find the 2A audiometer valuable in testing hearing in that it permits comparisons of hearing tests by different persons. They state that it is of assistance in ascertaining when sufficient treatment has been given in cases of progressive deafness, and that it thus prevents overtreatment. It also enables one to ascertain whether there is any improvement from the treatment and which lines of treatment are not beneficial; this is done by retesting and finding the patient able to hear a note he did not hear before the treatment. This justifies further treatment. They believe that the audiometer is indispensable in testing deaf-mutes who have residual hearing, and that it also enables one to pick out the "islands of hearing," if they are present and which can then be worked on.

The authors feel that the audiometer has one distinct drawback: in testing children up to 6 or 7 years of age, the test is inaccurate and more tedious than other methods because the instrument serves as a toy and it is impossible to have the children signal when the tones are no longer heard. The audiometer is also inaccurate in patients having head noises that may be confused with the instrumental tones. They state, however, that this error can be corrected almost entirely by means of a button which, when pressed on, shuts off these tones which recur when the button is released.

On various occasions I have expressed my views regarding audiometers, and have stated that while I decidedly favor instruments and methods of precision, I do not believe that the audiometers now on the

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7. Nemzel, Willard; and Hays, Harold: Clinical Observations on the Use of Audiometers in Testing the Hearing, Laryngoscope **36**:565 (Aug.) 1926.

market fulfil all essential requirements. In the first place, they are expensive; second, most of them do not provide means for properly testing bone conduction; third, most of them do not cover the complete range of tones, and fourth, the curves as usually plotted do not necessarily show the type of hearing impairment present. Tuning forks if properly used, and especially if supplied with the "damping constant" form a comparatively inexpensive and practical instrumentarium. The audiometer, however, has the advantage in that a curve or audiogram can be more quickly plotted than can be done with forks. The audiometer is also useful in testing large groups of school children. In a word, I believe that the audiometer is a valuable adjunct in many phases of functional hearing tests, but I do not think that it can or will, for the present at least, replace tuning forks in this field.

EXAMINATIONS IN SCHOOLS FOR THE DEAF IN CHICAGO

Shambaugh [8] reports that 290 children from the three schools for the deaf in Chicago were given complete ear, nose and throat examinations, including tests of the auditory function. The statistics are summarized:

Exactly one-half the children examined were found to be congenitally deaf while the other half had acquired ear trouble.

Total deafness existed in 57.9 per cent of the cases of congenital deafness and in 35.2 per cent of the cases of acquired deafness.

Partial deafness was found in 42.1 per cent of the cases of congenital deafness and in 64.8 per cent of the cases of acquired deafness.

Vestibular responses were present in 75.1 per cent of the cases of congenital deafness and in 62.07 per cent of the cases of acquired deafness.

Vestibular responses were absent in 24.9 per cent of the cases of congenital deafness and in 62.07 per cent of the cases of acquired deafness.

A total absence of vestibular responses and total deafness were found in 17.5 per cent of the cases of congenital deafness, and in 26.2 per cent of the cases of acquired deafness.

Presence of vestibular responses and total deafness were found in 40 per cent of the cases of congenital deafness and in 8.2 per cent of the cases of acquired deafness.

Absence of vestibular responses and total deafness were found in 6.2 per cent of the cases of congenital deafness and in 11.03 per cent of the cases of acquired deafness.

Presence of vestibular responses and partial deafness were found in

8. Shambaugh, G. E.; Hall, Alice K., and Holderman, J. W.: Statistical Studies of the Children in the Chicago Public Schools for the Deaf, Arch. Otolaryng. **2**:417 (Nov.) 1925.

34.5 per cent of the cases of congenital deafness and in 53.8 per cent of the cases of acquired deafness.

This was a painstaking investigation; its study in detail should prove of value. The data presented will be useful for future reference.

Robert Sonnenschein [9] calls attention to heredity and cites the work of Edward A. Fay, who reported 4,400 families in which one or both parents were deaf. There were 6,700 children, of whom 8.6 per cent were deaf. When both parents were deaf, 24 per cent of the marriages resulted in deaf children, and more than 25 per cent of the children were deaf. When the parents were related, 45 per cent of the marriages resulted in deaf children, and 30 per cent of the children were deaf. Alexander Graham Bell, in a survey of 300 marriages, found 56 per cent of the children deaf.

THE AUDIO CONTROLLER

Smith,[10] in a statement on the audio controller devised by R. W. Blucke and himself, states that "he has an apparatus which will revolutionize the method of instruction of deaf students." Many people who have not heard a sound for years are said to be able to hear all ordinary conversations distinctly without effort. With the apparatus all sounds or voices in any part of the room are picked up and made audible to the one or to any number of persons.

1. The apparatus consists of a supersensitive electrical microphone which records every sound wave with precision. The microphone, in turn, transforms each sound wave into a corresponding electrical wave or impulse which is conducted by means of suitable coupling transformers to the grid element of a three element radio vacuum tube. The principle or the action of the vacuum tube is to reproduce accurately in a highly magnified form the weak, electrical impulses applied to the grid element. In other words, the output of this tube is many times greater than the input, and is an exact electrical wave reproduction of the original sound waves.

Several tubes are cascaded to give several more stages of amplification of the original electrical impulse. The output of the last tube is led to a distributing block. (O. C. Smith is managing officer of the Illinois School for the Deaf.)

PROBLEMS OF THE HARD OF HEARING

Hays [11] states that the attitude of the otologist toward his deaf patient has changed. In cases in which previously a brief investigation, one or two inflations of the ear and a bad prognosis, were given in

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9. Sonnenschein, Robert: Tr. Chicago Laryngological and Otological Society, Arch. Otolaryng. **3**:300 (March) 1926.

10. Smith, O. C.: The Audio Controller, Arch. Otolaryng. **4**:160 (Aug.) 1926.

11. Hays, Harold: Some of the Problems of the Hard of Hearing and Their Solution, Ann. Otol. Rhinol. & Laryng. **35**:564 (June) 1926.

internal ear deafness, the otologist now is not content unless he makes satisfactory hearing tests, examines the causes of the ear condition and treats the pathologic condition as he finds it. In addition, an investigation of the possibility of various ailments far removed from the ears is essential, and requires proper care. The general resistance of the patient should be brought up to par and the psychologic state of the patient should be changed from one of depression to one of exalted happiness. The elimination of the charlatan will depend on the success of a campaign of education against him. The lay organizations for the deaf are helping a great deal in solving the problem of the deaf. These organizations are not only doing social service work, providing instruction in lip reading and giving financial aid, but now are also taking up the phase of prevention in this field by working with children at an age when they can be improved and sometimes cured. Investigations show encouraging results and demonstrate that it is most necessary to resort to a campaign of education until it becomes the rule for every school child to have his hearing tested at regular intervals.

GROUP TESTING OF CHILDREN

Knudsen and Jones [12] present a plan for group testing of the hearing of school children which they believe is valuable. Of the plans suggested previously, the one of Harvey Fletcher, who uses the phonograph audiometer and tests as many as twenty persons at one time through individual telephone receivers, seems practical. The volume can be controlled by the operator and gradually diminished to inaudibility. This test determines the persons who are hard of hearing, and these are segregated for further and more careful examination.

Another method which they present is to divide the children into groups of sixteen, using an audio-amplifier which develops sufficient energy for sixteen receivers. The tone is produced by the operator, and those hearing it press a button which lights a signal lamp in front of the operator; the individual continues to press the button until he is unable to hear the tone, and the reading is then noted by the operator. First one ear and then the other is tested for the entire range of sound. This shows the subjects who have less than 90 per cent of hearing; these are then segregated and at a later time given a more thorough examination for amplified voice, whisper and for bone conduction. Those who show more than 90 per cent of hearing for all tones and have normal upper tone limits are all promptly dismissed. The test requires only half an hour, and then an additional half hour for the more careful examination of those with hearing defects. The data are charted on a sample chart presented in the article. By this method about 46,260

12. Knudsen, V. O., and Jones, I. H.: A Plan for Group Testing of the Hearing of School Children, Ann. Otol. Rhinol. & Laryng. **35**:866 (Sept.) 1926.

school children could be tested in one year with one machine. The statistics at the end of the investigation would show how many children had 90 or 80 or 60 per cent of hearing; how many have a conduction or perception deafness or a mixed type of deafness, and how many show evidence of otosclerosis. From a practical standpoint, school authorities could notify parents, who in turn could consult a physician. The results of such an investigation would be of value in determining the best seating arrangement in the classroom; those with the greatest impairment of hearing would be seated nearest the teacher.

TUNING FORK TESTS

Démétriades [13] has done much work on the subject of cranial resonance and has published an article which I reviewed last year. He is of the opinion that the question of cranial resonance and its examination should be left to the otologist rather than to the neurologist. In the examination of cranial resonance he uses an apparatus (Kraniacoustikon), similar to that designed by Kless in 1908, which he attaches to the head of the patient. It is so arranged that the fork can be held steadily in one place; then the ears of the patient are connected with those of the examiner by means of tubing. The tuning fork should be struck forcefully, always placed at right angles to the skull, and kept in one definite position, either on the head or on the band of the apparatus. The author also calls attention to the fact (as emphasized by Claus and others) of the contralateral perception of sound by cranial resonance when the fork is placed on either side of the head lateral to the median line. After investigating the resonance in twenty-seven cases in which there were labyrinthine observations, the author comes to the following conclusions:

Persons with normal ears usually show greater cranial resonance to the right than to the left side.

In cases in which there is a loss of function of the labyrinth on one side, there is a diminished resonance on that side as compared with the opposite normal side. This was also found in cases of disease of the labyrinth in which there was a difference in irritability of one side as compared with the other.

The observation of better resonance on the side of the labyrinth which is more irritable is no mere chance, but has a definite etiologic basis.

The observation of better resonance on the side of the more irritable labyrinth may be absent in cases of fractures or tumors of the base of the skull, vasomotor disturbances, cerebral tumors and cases in which

13. Démétriades, T. D.: Investigation of Cranial Resonance: I. The Relation of Cranial Resonance to the Labyrinth Findings, Monatschr. f. Ohrenh. **60**:852 (Sept.) 1926.

there are arteriosclerotic changes and syphilis. In such cases, one is dealing with conditions that have extended beyond the labyrinth.

Examination of the cranial resonance is valuable not only in otology but also in neurology; to be of definite value, the whole picture of the ear and nose observations must be included.

Lorenz [14] states that the method of Schoen and Goldberger seems to promise aid in the solution of the problem, at times difficult, of determining the character of the impairment of hearing in combined otitis externa and otitis media. He used the phonendoscope to connect the ears of the patient with those of the examiner, and he heard the tone of the tuning fork placed on the mastoid process longer in cases of middle ear disease than in closure of the external auditory canal. To verify this result, Lorenz used an ordinary otoscope instead of a binaural hearing tube, and to a large extent was able to confirm the observations of Schoen and Goldberger, except that with changes in the middle ear the tone at times was shortened two or three seconds. The difference is probably due to the character of the otoscope, in some of which part of the tone is lost. This is of no practical significance, since the author has found that middle ear changes produce much greater prolongation of the sound (from twenty to forty seconds) than the mere conduction disturbances, which rarely give a prolongation of more than ten seconds.

As a rule, the author's procedure is as follows: He first determines whether the bone conduction of the patient is actually prolonged and not physiologic; this fact may be easily determined by comparing the diseased with the well side. When the tuning fork placed on the examiner's mastoid is no longer heard, it is set on the mastoid of the patient after the ears of the patient and the examiner have been connected by tubing. If the examiner can again hear the tuning fork, it means a middle ear lesion. The tests may be used, of course, not only in an otitis externa but in other cases of closure of the external auditory canal, or if there is a suspicion of a middle ear complication; but it is of greatest value when the examiner has been acquainted with the condition of the patient's ear for some time and can thus note the difference in the prolongation of bone conduction as compared with previous tests.

BONE CONDUCTION

Retjo [15] calls attention to the fact that the examination of bone conduction is one of the most important factors in otology, and that the therapy is often based on it. As a rule, it has been assumed on this basis that shortened bone conduction is a symptom of disease of the acoustic nerve. Retjo disputes this view as he is of the opinion that a

14. Lorenz, Hugo: Diagnosis of Middle Ear Disease by Means of Tuning Fork Tests, Orvosi hetil. **70**:386, 1926.

15. Retjo, A.: The Significance of Diminished Bone Conduction, Ztschr. f. Hals-, Nasen- u. Ohrenh. **12**:256.

pathologic condition of the labyrinth, either endolabyrinthine or perilabyrinthine, or disease of the nerve, or changes in elasticity of the labyrinth fenestra, may cause diminished bone conduction.

He believes that there can be only one stimulation of the auditory nerve and that is by means of a wavelike movement of the labyrinthine fluid which in turn stimulates the membrana tectoria, or rather causes this membrane to resonate. This stimulus must arise from both air and bone conduction of sound. However, he believes that the wave motion is different in air conduction from what it is in bone conduction.

With air conduction, transmission is brought about by vibration of the stapes, whereas with bone conduction the sound travels directly to the labyrinthine fluid and then outward toward the two windows of the labyrinth. This movement, however, does not travel only in one direction as it does with air conduction, but in two, since its energy acts on both windows. As the splitting of the wave motion into two directions produces a dissipation of the energy, Retjo believes that bone conduction under normal circumstances is less pronounced than air conduction. When the elasticity of the oval window is in any way lessened, and the wave motion is directed more and more toward the round window, less energy is lost, and thus the bone conduction is lengthened. But in those cases in which for any reason the elasticity of both fenestra is lessened, it is difficult for the energy to be transmitted from the fluid to the rigid fenestra, and thus the bone conduction is shortened. If the bone conduction is dependent on the condition of the labyrinth fenestra, then diminished bone conduction signifies disease of the auditory nerve, that is to say, the labyrinth, only when the normal condition of the fenestra is shown by good hearing of low tones. Retjo believes that in otosclerosis, for instance, in which the hearing of the low tones is poor, a shortened bone conduction may mean a diminution in the elasticity of both fenestra as well as involvement of the auditory nerve. He further asserts that pressure exerted on the normal drum membrane by means of a Politzer bag with the tip inserted in the external auditory canal results in a prolongation of bone conduction. This may also be observed if the drum membrane is weighted down with mercury with the patient in the reclining position. In this case perception of the low tones is entirely lost or becomes indistinct, the high tones are poorly heard and the bone conduction is prolonged. Weighting of the drum membrane always produces a definite and disagreeable tinnitus, which disappears when the weighting is discontinued. In cases in which there are large perforations of the drum membrane or cavities following radical mastoid operations, if the eustachian tube is not too patent, it is possible by means of air pressure (as with the Politzer bag) to influence or to act on the elasticity of both labyrinth fenestra. Under normal conditions, in the middle ear, it is difficult to fix both fenestra. In a pneumatic

chamber, the air pressure was increased one and a half atmospheres and it was found that bone conduction was shortened in all cases, not only with an intact drum membrane but also in cases in which there were perforations or in which radical operations had been performed. Retjo explains these observations of Hividt by stating that the increased air pressure by way of the eustachian tube acted on both fenestra.

In conclusion, he affirms that various experiments show, and further experiments will prove, that shortening of bone conduction may also be influenced by way of the fenestra.

I have always been of the opinion, and have expressed it in a number of articles, that the question of bone conduction is vital, and that it has within it many hints of the diagnosis, and hence the prognosis, of many ear conditions. For that reason any work that will throw further light on the question of bone conduction is welcome. Retjo has speculated for a long time regarding the function of the membrane of the round window. Since fluids are not compressible, the pressure produced by sound waves coming by way of air conduction, and acting on the foot plate of the stapes, must have an outlet for this pressure, and the secondary drum membrane may well act as a vent. Aside from the matter of conduction of sound, one should recall the fact that in an acute suppurative condition of the middle ear, the lowest turn of the cochlea, where the hearing for the high tones is situated, may easily become involved. This will probably explain to a certain extent at least the loss of hearing for high tones so often noted in acute otitis media, but which usually disappears after subsidence of the disease. There is a possibility, of course, that a toxemia by way of the blood stream would cause the same condition, but the local action of a suppurative process should be borne in mind.

Runge [16] calls attention to Bezold's theory that for the lower tones, at least, the only path of conduction is by way of the ossicles, whereas in recent times some authors maintain that these structures do not serve in this capacity at all. It is Runge's opinion that the lower tones travel either by pure cranial or by the craniotympanic route, while for transmission of the higher tones only the cranial route serves. He therefore at this time considers only the lower tones, especially that of *c* (128 double vibrations). In the determination of this question, it is important to observe under which condition one obtains the greatest degree of bone conduction. If the theory that the pure cranial conduction is etiologically the most active one is correct, some interference with the outflow of the sound from the labyrinth must be expected when fixation of the footplate of the stapes is present. This would give the

16. Runge, H. G.: The Significance of the Cranial and Craniotympanic Paths in Bone Conduction, Ztschr. f. Hals-, Nasen- u. Ohrenh. **12**:572 (Oct.) 1925.

highest degree of bone conduction prolongation, for according to Mach it is the summation of energy acting on the labyrinth which fixes the degree of stimulation, and this is determined by the relation between inflow and outflow.

Assuming a pure cranial conduction, the inflow of sound would be at an optimum with the outflow absolutely zero when there is interference with movement of the stapedial footplate. It is well known, however, that in doing the Gelle test whereby the footplate is pressed into its window, the hearing is made worse, that is, that the bone conduction is shortened and not lengthened. This applies, of course, if the tuning fork is placed on the head during the test. Stein and Cemach showed that it is not the increased intralabyrinthine pressure that produces the diminution, and Runge agrees with them. He also states that diminution in bone conduction may likewise be observed during the Valsalva test, and that in cases of otosclerosis without involvement of the inner ear there is only slight or no prolongation of the bone conduction. According to Runge, experimental investigations show that fixation of the footplate does not give prolongation of bone conduction, but rather tends to a shortening thereof, although under the assumption of a pure cranial conduction the inflow of sound would be at an optimum here, the outflow being interfered with materially. On the other hand, slight improvement in sound conduction in pathologic fixation is afforded by the improved transmission. Therefore, pure cranial transmission of sound seems wholly improbable. On the other hand, in cases with complete fixation of the stapes there is still hearing for the lower tones such as *c* (128 double vibrations), and therefore Bezold's theory of a pure craniotympanic conduction cannot be absolutely correct. When the outflow of sound as conducted from the cranium through the external auditory canal is interfered with by paraffin, cerumen or water in the meatus, the bone conduction is greatly increased. Runge therefore regards this as a proof of the influence that the ossicular chain has on the transfer of sound by way of bone conduction. When he uses his water filling test in otosclerosis, he does not observe any prolongation of bone conduction, such as one obtains with a freely movable ossicular chain, even when there are some pathologic changes in the inner ear. According to him, this shows that despite improved conduction of the sound waves to the drum membrane there is no better transmission of sound, and that the waves do not go the way of the promontory, or the round window, but only by way of the ossicular chain. His experiments further show, contrary to the views of Schoen and Goldberger, that it was not improved cranial resonance which gave better hearing. Runge is of the opinion that the use of a noise apparatus in the external auditory canal does not influence the inner ear, but simply renders the ossicular chain incapable of transmitting or carrying over the sound.

His conclusion is that with the use of higher tones the cranial conduction is markedly improved when compared with the craniotympanic route.

Claus [17] calls attention to the fact that many errors in bone conduction are due in part to the examiner and the manner in which he holds the fork; in part to the patient, in that he may have the mouth open or closed, that he may elevate or depress the angle of the mouth, may separate the upper and lower maxilla or press them together as the case may be. There is a difference in bone conduction, varying from five to ten seconds, depending on the various factors, and there is a possibility in some instances that as great a difference as twenty-five seconds may exist. Claus used an unweighted c-1 (256 double vibrations) fork and placed it on the vertex instead of on the mastoid process, allowing it to rest against the skull of its own weight, for when placed on the mastoid process it is difficult to hold it in position without exerting considerable pressure. Then again, it is not placed on the mastoid process so as to be able to avoid the so-called diagonal resonance of Schoen and Goldberger. According to them, the fork, if placed on the skull anywhere except on the median line, is best heard on the opposite side of the skull. Claus objects to the term diagonal resonance and prefers to call it "crossed perception," a term which really designates what actually takes place as far as the subject is concerned but does not refer to the phenomenon, the exact nature of which is not yet definitely known. This procedure or the observation of the phenomenon is not original with Schoen and Goldberger, since it was already described by a good many men, including Kessel, Lucae, Tröltsch, Urbantschitsch, Eitelberg, Politzer, Iwanow and Frey. Schoen and Goldberger lay stress on it in the diagnosis of ear and nasal accessory sinus disease, since the test controls the subjective statement of the patient, and checks the objective observations by means of a double phonendoscope, or stethoscope, which they employ. Claus says that it does not give uniform and dependable results. Even if the fork is placed on the median line of the skull, persons whose ears are normal may not hear it in the whole head, or equally well in both ears, but it is at times, for no well-known reason, lateralized to one or the other side. This is, of course, an observation that many have made with reference to the ordinarily performed Weber test. However, Claus, quoting Schoen and Goldberger, states that when the fork is placed on the lacrimal bone to test the ethmoid sinus, the tone is supposed to be always heard on the opposite side of the head, but that when the stem of the fork is moved slightly toward or away from the median line, at times the sound is heard on the same, and at other times on the opposite, side of the head. Even if an objec-

17. Claus, Georg: Cranial Bone Conduction and Crossed Perception, Monatschr. f. Ohrenh. **60**:315, 1926.

tive control is instituted by means of the phonendoscope connecting the ears of the patient with those of the examiner, it is not always reliable, since, as previously noted, the patient may cause a difference in the lateralization of the sound by changes in the position of the angle of the mouth or the closing together of the jaws.

Claus' article in the original is of considerable length; it gives details and is deserving of much more consideration than is possible in this summary of the literature. It is of a critical character and comprehensive but has a number of repetitions. The author is skeptical, especially with reference to the attempt to localize sinus disease by means of diagonal resonance.

Goldberger and Schoen [18] repeat statements made in previous articles to the effect that the usual tests, such as the Rinne, Schwabach and Weber, are largely subjective, and that in these tests one must depend on the statements of the patients for the results. In order to have an objective control, they have been using the so-called skull phonendoscope, which is is a double stethoscope two ends of which are inserted into the examiner's ears and the other two into those of the patient. The authors use either the unweighted c-1 (256 double vibrations) or a-1 (435 double vibrations) forks, and believe that by their method they are not merely testing the conduction of sound through the bone and the perception ability of the inner ear, but that they are actually utilizing the "resonance" of the skull. Of course, in their experiments, unless the fork that is used has practically the pitch of the natural frequency of the skull and its contents, one is dealing with forced vibration and not with a natural resonance.

As described in former articles, the ears of the examiner and those of the patient are connected, and the tuning fork is placed on various points of the head, such as the median line, the vertex, the forehead, the root of the nose; in examining the sinuses, the fork is placed on the supra-orbital ridges for the frontal sinus, on the lacrimal bone for the ethmoid sinus, on the superior maxilla at the angle between the upper lip, the nasolabial fold for the antrum of Highmore, and at the region of the mastoid antrum for testing the mastoid process. Then, as a control, the fork is shifted to the examiner's head, and by simply closing off the tubing on one side or the other, one is able to determine on which side of the head the sound is perceived.

When the tuning fork is placed on the median line of the vertex in a normal person, the skull is divided into two equal and symmetrical halves, and the sound is not lateralized to either side. If, however, the fork is placed on any point lateral to the median line, the skull is divided

18. Goldberger, K., and Schoen, S.: The New Skull Resonance Test and Its Significance in the Diagnosis of Ear and Nasal Sinus Conditions, Ztschr. f. Hals-, Nasen- u. Ohrenh. **12**:578 (Oct.) 1925.

into two unequal vibrating masses, and therefore the two parts have unequal resonance. The sound will be heard louder in the side diametrically opposite the point on which the tuning fork is placed. For instance, if the fork is placed on the left normal mastoid (without touching the auricle) and the examiner connects his ears with those of the patient, he will hear a sound in his own left ear corresponding to the one on the right side of the patient, which is opposite the side on which the fork is sounding. This was also observed by Politzer and Frey, but the subjective statements of the patient were not controlled objectively by them, and this phenomenon Goldberger and Schoen call "diagonal resonance."

Every change in the vibrating mass in the sense of an increase of the mass of one side of the head, for instance, a middle ear suppuration or disease of the nasal accessory sinuses, a vasomotor disturbance or tumor of the brain, changes the resonance condition so that the greater the vibrating mass the more it resonates.

The authors emphasize certain advantages of their method: First, the point at which the fork is placed does not change throughout one examination. Second, the difference in intensity with which the fork is struck does not influence the test, as it is only a matter of comparing resonance of one side with the other. Third, this method embraces the consideration of the whole complex, which cannot be evaluated when tested with the ordinary tuning fork tests. Last, it is a more delicate test than the others.

This method of Schoen and Goldberger is not new, for it has been used before, as can be learned in discussions by, and articles of, other authors. This method is not nearly so clear and so reliable as the authors themselves seem to believe. Of course, every measure that helps in testing the patient in an objective manner is of the greatest value, and should be investigated to the fullest extent. If shown to be of definite and permanent value, it will be of service in the functional testing of hearing.

I have used this method in a number of cases but have been unable to decide for myself whether it is of real assistance or not. The point that impressed me is that the examiner's ears must be normal or else he must make due allowance for lateralization in his own case before drawing conclusions regarding the patient's status. Where there is only a slight difference between the intensity of the sound heard on one side or the other, it is often difficult, even with intermittent closure of one tube or the other to decide on lateralization or "diagonal resonance." As with the ordinary Weber test, one cannot always explain the lateralization that varies from the accepted postulates. Another point to be remembered is the fact that in endeavoring to determine the diagonal resonance with reference to the nasal accessory sinuses (and this fact has been

strongly emphasized by Claus in his article), a slight difference in the point at which the fork is placed, for instance, on the lacrimal bone in testing the ethmoids, will give a difference in lateralization. As previously stated, a number of authors in Germany and Austria disagree with the enthusiastic claims of Goldberger and Schoen. In fairness to all, this test should be used many times before a statement as to its clinical significance is made.

Cohen and Nussbaum [19] believe with many others that the lateralization of the tuning fork sound from the median line of the patient's skull is due to an increase in the mass proper of the skull, and to the difficulty met by the sounds in penetrating the ear. The authors feel that the results of the usual tests, such as the Weber, Rinne and Schwabach, depend on the information obtained from the patient without any objective control, and thus may lead to faulty and unreliable deductions. As a result, many investigators have searched for an improved method based on a more scientific foundation and for a more simplified clinical technic. Goldberger and Schoen of Vienna made an advance in this direction with their test known as a skull phonendoscopy, which is based on the resonating properties of the bone and of the cavities of the head. The authors believe that the present conception of "bone conduction" is meaningless, unless it is confined to the physical property of transmission in a way similar to other mediums, such as air and water, in which the vibrating body (the skull) absorbs energy in the form of vibrations from the periodic pulses of the external force (the fork), and soon vibrates with large amplitude. In placing a tuning fork on the skull, the latter is compelled to surrender its natural vibrations and those of the fork are forced on it. If one of low pitch is used (128-256 double vibrations), coinciding with the natural low frequency of the skull, a resulting resonance or reinforcement of the sounds emitted by the fork is obtained. The pathologic condition of the ear has nothing to do with the texture of its covering bone except in "sclerosing chronic mastoiditis"; when it is said that shortened bone conduction equals nerve impairment, the bone per se may not be diseased or, vice versa, the underlying nerve may be normal.

In middle ear trouble there is an increased resonance, a similarity between the statements of both patient and examiner, and the diagonal resonance is to the same side. In inner ear affections the patient's perception is impaired, he hears less than the examiner, perception is shorter than resonance and the diagonal resonance is to the opposite side. In obstruction of the external canals, the patient apparently hears longer than the examiner and perception is apparently longer than resonance.

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19. Cohen, Samuel, and Nussbaum, David: A New Method for Testing Hearing, Arch. Otolaryng. **3**:242 (March) 1926.

This method of testing the hearing is said to be more rapid than the older methods; the subjective observations of the patient are controlled by the objective observations of the examiner, and the same points of contact between fork and bone are always used during the entire procedure, thus avoiding the faulty conclusions of the ordinary way of testing.

Cohen and Nussbaum base their opinions on careful study of the Goldberger and Schoen method of testing.

Pohlman and Kranz [20] present a report of seven cases in which air and bone acuity were tested and charted, using the bone activating telephone on the forehead for bone sensitivity. The authors' observations substantiate their previous statements that both air and bone transmitted sounds normally enter the cochlea through the stapedial foot plate. This with other experimental work they are doing leads them to doubt the possibility of differentiating a conduction from a perception deafness, until the knowledge of the acoustic system has advanced enough to establish exactly where an interference in the sound transmission apparatus is located. A technic may then, perhaps, be developed to adapt the individual to his defect.

Fowler [21] holds that the usual methods of measuring bone conduction are inaccurate and that there may be 8 seconds variation in a normal ear. It is desirable to measure bone conduction accurately, rationally, and in clear units of measure so that measurements can be correlated and charted along with air conduction.

A simple rational method of measuring both air conduction and bone conduction in this manner is described. It is based on making the decrement in intensity of tuning fork tone the same for air as for bone conduction; in other words, the damping is made the same for both. This is accomplished by continuing to alternate the placement of the fork between the mastoid and the meatus until the sound ceases to be heard by both. Advantages and variations of the method are noted.

Tuning forks should be calibrated so that all tests may be in the same units of measure. A method for obtaining any desired accuracy by employing the law of probability with calculations, illustrating normal cases, is given, and some experiments show that:

An accuracy of less than a second's variation was obtained in the subjects tested (less than 2 sensation units).

Closing the meatus causes increase in bone conduction whether the fork is on the vertex or mastoid, or any other part of the skull.

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20. Pohlman, A. G., and Kranz, F. W.: Is a Differential Diagnosis Between Middle and Internal Ear Deafness Possible? Laryngoscope **36**:284 (April) 1926.

21. Fowler, E. P.: Fundamentals of Bone Conduction, Arch. Otolaryng. **2**: 529 (Dec.) 1925.

The increase with a 356 double vibration fork was about 9 seconds (16 sensation units).

The increase is equivalent to an increase of ten times in amplitude.

A similar difference exists between vertex and mastoid placement of the fork.

Runge's water filling method causes an increase in amplitude of ten to twenty times the normal.

No lesions causing this amount of increase have been encountered.

Pohlman and Kranz [22] mention the explanations of paracusis willisiana, given by Politzer, by Urbantschitsch and by von Troeltsch (the latter in 1862). He states that persons suffering from paracusis have a conduction type of deafness with a deficiency most pronounced in the lower range of frequencies. They are, therefore, not so sensitive to noises as persons with normal hearing; whereas the normal persons, in the presence of noise will unconsciously raise the intensity of their voices above the level of the masking effect which is sufficient to enable the deaf person, who is not so thoroughly masked, to understand the conversation better in a noisy place. The fact that certain persons with impaired hearing hear better in a noisy place is dependent on the fact that normal persons do not hear so well under these conditions, and is, therefore, not a real phenomenon so far as the deaf person is concerned. Kranz also offered this explanation a year ago, and Knudsen confirmed it with observations on several deaf subjects. This probably may be an explanation of the fact that there is increased bone transmission in these cases, according to the writers. Prolonged bone conduction means that a given person hears a vibrating fork by bone longer than the examining physician himself. These tests are usually conducted in an office in which there is more or less noise. Under these conditions the deaf person has the advantage similar to that which he has for conversation in the presence of a disturbing noise due to his deficient acuity for the lower frequencies. The difference between the two observers would probably change, disappear or reverse, if the tests were conducted in a sound proof room.

The negative Rinne test result may also be a consequence of the deficiency in air acuity. If the acuity for air transmitted sounds is lowered while the bone acuity is practically normal, the subject will hear the fork relatively longer by bone transmission than by air transmission when compared with a person of normal hearing.

A certain amount of masking due to a background of extraneous sound experienced by the normal person is greatly reduced in those of lowered air acuity. The diminished air acuity also causes a subject with

22. Pohlman, A. G., and Kranz, F. W.: Quantitative Tests on Bone and Air Acuity in Paracusis Willisii, Ach. Otolaryng. **3**:136 (Feb.) 1926.

good bone acuity to judge the intensity of his voice by bone transmission, as opposed to the normal person who judges the intensity of his voice through air transmission.

Two cases are presented in which the patients displayed four symptoms; namely, paracusis willisii, a negative Rinne reaction, so-called prolonged bone transmission and a speaking voice of low intensity, which appears to be commonly associated with, and due to, the same general cause. The lowered air acuity with practically normal bone transmission may produce all these symptoms. This lowered acuity in both ears for the lower frequencies, which is characteristic of most noises, is due largely to mechanical interferences in the sound transmission system, while the excellent bone transmission shows that the end organ is in good condition, even if the route selected for bone transmission is shown to be an abnormal one.

Pohlman and Kranz [23] found that the occlusion of the external auditory canal (with dental impression wax) does not effect the same degree of blocking for all frequencies of air transmitted sounds. One hundred and twenty-eight double vibrations require 14.5 times the intensity needed without the plug, 512 double vibrations take 190 times, 331 double vibrations require 1,024 times and 2,048 double vibrations require 10,000 times. In placing the fingers in the ears to gain an idea of what a person with conduction deafness hears, the acuity for high pitched sounds is lowered; a person with conduction impairment has lowered acuity for low pitched sounds, and is not as deaf for the higher frequencies. The effect on bone acuity of partial occlusion is a slight increase at 128 double vibrations with an increase of bone acuity on the affected side, increasing definitely up to 512 double vibrations, dropping off slightly at 1,024 and having no effect at 2,048 double vibrations. The advantage of complete occlusion over partial is most pronounced at 128, and gradually drops off to a negligible effect at 1,024 and 2,048 double vibrations. Complete occlusion shows its advantage over the unoccluded condition more at the lower frequencies than at the higher, rising somewhat from 128-512, decreasing at 1,024, and negligible at 2,048. The enhancement of bone transmission at 1,024 double vibrations is almost entirely due to partial occlusion. Bone acuity is increased more in complete than in partial occlusion at the lower frequencies as 128-512 and drops off gradually to a negligible quantity at 1,024-2,048.

Pohlman and Kranz [24] using the electrical oscillator with a modified telephone receiver on normal persons, determined the effect of varying

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23. Pohlman, A. G., and Kranz, F. W.: Influence of Partial and Complete Occlusion of the External Auditory Canals on Air and Bone Transmitted Sounds, Ann. Otol. Rhinol. & Laryngl. **35**:113 (March) 1926.

24. Pohlman, A. G., and Kranz, F. W.: The Problems of Middle Ear Mechanics: Chapter III. Binaural Acuity for Air and Bone Transmitted Sound Under Varying Conditions in the External Auditory Canal, Ann. Otol. Rhinol. & Laryng. **34**:1224 (Dec.) 1925.

conditions in the external auditory canal on binaural acuity for air and bone transmitted sound. Their observations showed:

1. The observational error in making bone transmission tests is greater than that found for air acuity. The relatively wide variations in bone acuity are not necessarily dependent on similar variations in the air acuity.

2. Good bone acuity in normal persons is somewhat more closely associated with good than with poor air acuity.

3. The advantage to bone sensitivity of the occlusion of the external auditory canals seems to be a function of the frequency. The advantage is the greatest in the lower frequencies and gradually drops off until at 2,600 cycles per second one of the four observers used was benefited by means of the occlusion.

4. Tests on the effects of plus and minus pressures in the air of the external auditory canal showed that the greater sensitivity for sounds both by bone and air transmitted was at atmospheric pressure. Plus and minus pressures decrease the acuity for air transmitted sounds.

Pohlman and Kranz [25] show that there is a difference in bone acuity when the external canal is occluded with either water or dental wax. They used six observers and the transmission was tried from the forehead, from the mastoid adjacent to the ear which was filled with water, and from the mastoid of the opposite side. They found that bone transmission by way of the mastoids is better than by way of the forehead with the ears open, and that bone transmission from the mastoids on the average is more affected by water than is bone transmission from the forehead. They also found that filling the ear with water effects the greatest improvement for low tones in the ears which are poorest in bone transmission, and that filling the external canal with water causes a greater improvement in bone transmission from the mastoid on the side which is filled than from the mastoid of the other side. Furthermore, good bone transmission is slightly more closely associated with good than with poor air acuity. With wax occluding either one or both canals, the bone acuity by way of the forehead is more affected than the acuity by way of the mastoid, whereas bone acuity by way of the mastoid is more affected than acuity by way of the forehead by filling the external auditory canal with water. The occlusion of one external auditory canal affects the bone acuity from the mastoid on the closed side more than the acuity from the mastoid on the opposite side, with the exception of the higher frequency with water occlusion, and at the two lower frequencies with wax occlusion.

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25. Pohlman, A. G., and Kranz, F. W.: Monaural Tests on Bone Acuity Under Various Conditions with Some General Comments on Bone Acuity, Ann. Otol. Rhinol. & Laryng. **35**:632 (Sept.) 1926.

The type of occlusion also makes a difference:

1. Wax is distinctly more effective than water in improving bone acuity by way of the forehead, and is a little more effective both by way of the forehead and the mastoids when the wax is placed in both ears.

2. With one ear occluded, the bone acuity by way of the mastoid on that side is slightly more affected by water at the lower frequencies, and by wax at the higher frequencies.

3. With one ear occluded, the bone acuity from the mastoid opposite the closed ear is in general more improved by wax occlusion than by water occlusion.

Pohlman and Kranz state that in general the maximum effect of occlusion is at 256 double vibrations and decreases markedly as the frequency rises, until at 2,048 the water occlusion is a detriment and the wax occlusion is of small benefit.

In the authors' general comment on bone transmission of sound, they show in various ways that the vibration of the whole cochlea is not essential to the reception of bone transmitted sounds. They state that since both bone and air transmission are affected in a similar way, by pressure on the drum membrane, it shows that at least part of their paths to the end organ are identical, and demonstrates likewise that the ossicles also enter into the bone transmission. The fact that bone transmission takes place by means of the outer parts of the air transmission apparatus serves strongly to emphasize the fact of the perfect acoustic insulation of the inner ear. They maintain that in persons with normal hearing the inner ear is well protected from direct agitation through bone transmitted sounds, and that these sounds reach the inner ear at least by way of a part of the same mechanism of the external and middle ear, such as is used for air conduction.

These two investigations have been thorough, and I believe that the profession will be benefited by the results of these studies. It is the cooperation of these men, together with other physicists like Fletcher, Bunch and Knudsen, which is helpful to the otolaryngologist.

THE WEBER TEST

Macfarlan [26] adds a new corollary to the analysis of the Weber reaction: When the Weber test is used with forks of different pitches, it may be found that the hearing is referred to one side with one pitch and to the opposite side with a different pitch; this means that in one part of the range air conduction and bone conduction may have an entirely different relation from that in another range. He presents five

26. MacFarlan, Douglas: The Alternating Weber Test and a New Method of Determining Weber Lateralized in Doubtful Cases, Arch. Otolaryng. **3**:144 (Feb.) 1926.

cases to verify this point. The Konig 488 double vibration fork was used and was struck with a swinging pendulum to produce a dependable blow. The Struycken-Schaefer monochord was used for the high tones. The fork was placed on the brow in the midline. In patients with bilateral involvement in whom bone is equal on both sides, the Weber test usually is referred to the side having the better air conduction. An exception to the rule that in the Weber test the sound is referred to the ear showing the greatest bone conduction is found in the Weber-Schwabach paradox described by MacKenzie. This states that in patients with acute ear congestion, as in the prodromal or active stages of acute middle ear suppuration, the Weber test is referred to the diseased side, but a shorter hearing time for bone conduction is obtained with the fork on the mastoid antrum of the diseased side. This appears only in catarrhal and never in nerve deafness. The explanation for this phenomenon is that acute congestion and inflammation of the mastoid cause a reduction in the resonance of bone conduction when the fork is held against the antrum, with the resonance not affected when the fork is placed on the brow.

MacFarlan presents a new method for determining the lateralization of the sound in the Weber test in children and ignorant adults. A diagnostic tube is placed in each ear of the patient, with the opposite ends in the examiner's ears. The fork or monochord is placed against the patient's brow. The ear to which the Weber test should be referred disperses a louder tone to its ausculation tube, and this to the corresponding ear of the examiner. It is necessary for the examiner's hearing to be normal; further, it is natural for some to distinguish differences in intensity better than others. The test serves as a check in the Weber test as usually taken, and an aid in the bone conduction test as independently taken. It eliminates the subjective element and is excellent in testing children and stupid adults who cannot discriminate between tactile and auditory senses.

This test is in principle much like the test for cranial resonance proposed by Goldberger and Schoen.

TESTS IN OTOSCLEROSIS

Bunch [27] studied sixty-three cases of definitely diagnosed otosclerosis, and presents data from the point of view of hearing alone, with the hope that this material can be correlated with the observations of others and the conditions noted by the pathologist. He found that eighty-four per cent of the patients were under 45 years of age, and that there was much greater frequency in females than in males. The Bezold triad formed a basis for differentiation of the typical cases, which did not

27. Bunch, C. C.: The Functional Tests of Hearing in Otosclerosis, J. Laryng. & Otol. **41**:565 (Sept.) 1926.

deviate from any of the conditions of the triad, from the atypical cases, which differed in one or more of the three characteristic points. Eighty-eight ears had prolonged bone conduction, all but four of which were in the typical group. Twenty-nine ears had decreased bone conduction and were listed in the typical group.

A marked loss of acuity for the higher musical tones, contrary to the knowledge gained from the literature, was found in 58 per cent, who were unable to hear a c-5 fork (4,096 double vibrations).

The upper limit of audibility by bone and air conduction made with the Struycken monochord showed that 78 per cent of the ears tested had the upper limit by bone conduction, 2,000 double vibrations or more above that for air conduction. The pitch range audiometer curves in these cases showed at least three different types of curves that are more or less similar to those in the case of middle ear, inner ear and the combined type of deafness.

The frequency of a marked loss of acuity for the c-5 fork, as mentioned earlier, holds for each of the three types. This adds material evidence to the probability of a neural involvement in the inner ear type and the combined type, since in cases of known involvement of the nerve the hearing for this fork is markedly impaired, whereas patients with the middle ear type of deafness have approximately normal hearing for this fork.

Paracusis willisii was present in 59, 54 and 66 per cent, respectively, in the inner, middle and combined types.

Tinnitus was a disturbing symptom noted by 90, 87 and 92 per cent, respectively, in the three types, and 25 per cent of each group reported that tinnitus was the first symptom noted. It seems possible that the dominating cause in any type may appear at the onset, but may later assume such form that the condition of hearing noted in another type may alter the original observations of the hearing tests. In conclusion he states:

> Evidence is presented for classifying the cases of otosclerosis into three groups on the basis of tests for auditory acuity which show details through the range of hearing. For want of better names these have been called the "middle ear," the "inner ear" and the combined types. The audiometer curves of the three groups correspond closely to the curves given in cases of pure middle ear lesions, pure inner ear lesions and to those in which there is undoubted evidence indicating an involvement of both middle and inner ears.

MALINGERING DEAFNESS

Scal [28] presents tests for the detection of pretended deafness, which commonly arises after injuries. If the patients are seen at an early date, malingering can be readily unmasked, and if examination is made

28. Scal, J. C.: Malingering Deafness, Arch. Otolaryng. **3**:237 (March) 1926.

soon enough, a traumatic drum rupture can easily be ascertained. Scal states that the success of detecting malingering deafness depends on four points: (1) the length of time after an accident that the patient complained of the symptoms; (2) the symptoms, such as unconsciousness, vertigo and vomiting; (3) when the symptoms were noted by a physician, and (4) the variations in the patient's story.

Patients with deafness of long duration usually speak with a characteristic monotone found in advanced and in genuine cases. If one ear is affected, the voice is unchanged and the head will be turned naturally and involuntarily in the direction of the speaker. It must be remembered also that people in certain occupations, such as riveters, ironworkers and boilermakers, are partially deaf.

Malingerers rarely assert that they have double deafness, and usually try to make their deafness apparent by repeating words in an uncertain manner. In cases of doubtful double deafness, the patients should be placed in a hospital for observation. In these cases, Boissein makes insulting remarks about the patient in his presence and observes whether he betrays himself by flushing or changing his facial expression, which would indicate the existence of auditory perception.

The hearing tests used are divided into those for nerve, labyrinth and air conduction deafness. While one ear is being tested, the opposite is closed tightly by the patient's finger. To obviate the possibility of the unaffected ear interfering with the hearing tests, the Bárány noise apparatus can be used to occupy the attention of that ear.

There are several voice tests, such as Callahan's test, in which rubber tubing is used with couplings for the addition of sections and a mouthpiece. With equal sized tubings, the voice is heard in both ears. With unequal lengths, the patient is conscious of hearing the voice in the ear connected with the short tube, which is within the hearing distance. The deaf person will admit hearing the voice as the tube going to the good ear is always within the hearing limits of that ear; but when he hears in the supposedly deaf ear, he will deny hearing anything, and so he is easily detected. In another test, a tube is placed in each ear and two persons speak into each tube on different subjects and at different rates. If he hears in both ears, he will confuse the voices and be unable to understand either of the people talking. Scal also mentions the watch test described by Erhard; the electric test described by Brownfield; Lombard's test and the voice test in which the good ear is occluded with the finger and the voice is progressively raised until it should be heard in the occluded good ear, which the malingerer will deny. The stethoscope test and tuning fork tests also are reviewed. The author reports two cases of malingering deafness. He states that no one should be called a malingerer unless the responses to the various tests are conclusive of fraud or exaggeration. The mere rupture of a drum does

not necessarily mean especially diminished hearing. Kopetsky and Schwartz (*Laryngoscope* **33**:310 [May] 1923) state that the fact that the vestibular reactions are normal in a totally deaf ear does not necessarily mean that the person is a malingerer, and complete deafness may occur without involvement of the static labyrinth.

Of all the tests for the detection of assumed unilateral total deafness, I believe the Stenger test or a modification of it is the best. The principle on which it is based is the masking of one ear with the sound of a tuning fork held closer to it than a tuning fork of the same pitch which is vibrating at a greater distance from the opposite ear. It seems unfortunate that this test has not received the recognition of the modern textbook which it deserves, and it is only in an occasional article that it is mentioned. The reader is referred to my review of the literature on the functional testing of hearing which appeared in the January, 1925, issue of the ARCHIVES OF OTOLARYNGOLOGY for a description in detail of this test. In cases of malingering unilateral total deafness, it is possible to unmask or to discover it in almost every instance if the Stenger test is made carefully.

THE WAGENER SHAKING TEST

Politzer believed that binaural hearing was more efficient than monaural because there was a summation of stimuli, while Pohlman and Kranz are of the opinion that acuity of hearing binaurally is only slightly better than monaurally.[29] The author mentions the various methods employed for excluding the well ear—the rubbing of the auricle with the palm of the hand as done by Kayser; the use of compressed air, according to Voss; the use by Lucas and Davidson of tubing and pneumomassage apparatus, and, last, violent noise apparatus, such as the one used by Bárány and the electrically operated one used by Neumann. The advantages of the air compression method are pointed out, also the objection to the noise apparatus of Bárány that, as the springs of the mechanism become weaker, the noise lessens, and that the sounds are often carried to the ear opposite to the one being tested and influence it. The method of Wagener consists in placing the dry or moistened index finger in the external auditory canal, then making a shaking movement, which causes a vibration of the walls of the external auditory meatus; this drowns out the sounds entering that ear while the opposite one is being tested.

Hünermann found that the procedure produced a feeling of warmth in the external canal, and therefore advises that the shaking be done only a few seconds before the test with voice or tuning fork is about to be

29. Hünermann, T.: Observations of the Utility of the Wagener "Shaking Test" in the Determination of Unilateral Deafness, Beitr. z. Anat. Physiol., Path. u. Therap. d. Ohres. **24**:313 (Aug.) 1926.

performed. He uses Edelmann forks, beginning with C—(64 double vibrations), employing weighted ones until he reaches c-3 (1,024 double vibrations). The forks are struck with a rubber hammer, and a stop watch is used to determine the length of time the forks are heard.

The investigation was conducted along four lines: (1) the determination of the influence on the hearing acuity of the open ear with the "shaking test" in the opposite ear; (2) the determination of the passage of sound of a tuning fork into the ear being shaken; (3) the Weber test during the shaking of one ear, and the (4) difference in results between the "shaking test" and the use of the Bárány noise apparatus.

The author's conclusions in the first test were: that the shaking in one ear does, to a slight extent (though without practical significance) diminish the hearing on the opposite open ear.

He found that when the fork was held near the ear that was being shaken some of the sound penetrated, showing that occlusion and masking were not complete. He also observed that transmission to the ear that was being tested did not seem to be greater for high tones than for middle tones, but that the lowest ones were prevented from entering.

It was found that using the shaking reaction in one ear causes a lateralization of the Weber to that side; this was especially true the lower the pitch of the fork employed.

Relative to the influence on the acuity of hearing of the open ear while the Bárány noise apparatus was being used, it was found that there was considerable diminution in hearing by air conduction with the noise apparatus used in the opposite ear. The author concludes that in an examination in detail for the determination of the remains of hearing it is not feasible to employ the Bárány noise apparatus in the opposite ear. Nevertheless, the noise apparatus has a certain advantage over the shaking test as shown here.

Regarding the penetration of sound into the ear in which the noise apparatus is placed when the opposite ear is closed by pressing in the tragus, the author states that it is not necessary to produce noises by means of appliances in both ears, as this procedure would have the disadvantage of causing much noise. With one ear closed with the Bárány noise apparatus, and the other one closed by pressing in the tragus, no noise can penetrate into the former ear, even when a c-5 fork (4,096 vibrations) was used. Hünermann feels that Bárány's assertion that the use of the noise apparatus renders an ear practically deaf to most sounds is justified. The author is of the opinion that the "ear shaking" occlusion is good for all practical purposes and is, at the same time, free from any possibility of injury to the ear, such as might be sustained by the various noise apparatuses.

The occlusion of one ear while the opposite one is being tested has always been quite a problem. Of course, when any sound is produced it

is appreciated partly by air and partly by bone conduction. Even if an ear is firmly closed, the sound waves strike the skull and are transmitted to the same or to the opposite side so that this side cannot be entirely eliminated. The principle of producing a great noise in one ear and thereby masking the sounds that are going into that ear, thus allowing appreciation of sound by the opposite ear called forth the invention of the many methods mentioned by Wagener. However, about fifteen or sixteen years ago, at the suggestion of N. H. Pierce, normal ears were tested by Dr. A. Lewy and myself by inserting the ball-shaped end of the stem of the Bezold a-1 fork (435 double vibrations) into the external auditory meatus, which would, while the fork was vibrating, produce such an intense sound that this ear would be entirely occluded. In order to use forks of other pitches, we attached to their stems a pear-shaped hard rubber tip which would then be inserted into the external auditory meatus. The forks proved to be good noise apparatuses, except for the fact that the vibrations would die down in a short time, and the fork would have to be removed and be struck again. However, they can be used successfully for this purpose, and thus obviate the purchase of extra apparatus for the ordinary functional hearing tests. Furthermore, when a comparatively low pitched fork was used, the sound was not carried by air conduction to the opposite ear so that that ear was not influenced thereby.

CORRECTION

A printer's error occurred in the article by Dr. Henry P. Schugt (Arch. Otolaryng., December, 1926) in the transposition of a line from the fourth to the second paragraph on page 483. The first sentence in the second paragraph should read: "In the second case there was an ulceration of the left ventricular band which healed three weeks after the resection of the superior laryngeal nerve."

News and Comment

NATIONAL SOCIETY MEETINGS

The American Ophthalmological Society will hold its next annual session in Quebec, Canada, June 27-29, 1927. President, Dr. William Zentmayer, 1506 Spruce St., Philadelphia; secretary, Dr. Emory Hill, Professional Bldg., Richmond, Va.

The American Academy of Ophthalmology and Oto-Laryngology will hold its next session in Detroit, September 12-16, 1927, at the Book-Cadillac Hotel. President, Dr. Edward C. Ellett, Exchange Bldg., Memphis, Tenn.; secretary, Dr. L. C. Peter, 1529 Spruce St., Philadelphia.

LOCAL SOCIETY MEETINGS

COLORADO: The Colorado Oto-Laryngological Society meets on the first Saturday of the month from October to May, at the Assembly Room of the Metropolitan Building. President, Dr. David A. Strickler; secretary, Dr. C. Howard Darrow, Metropolitan Building, Denver.

ILLINOIS: The Chicago Laryngological and Otological Society meets at 6 p. m. on the first Monday of the month from October to May, in the Grill Room, Stevens Restaurant, 16 N. Wabash Ave. President, Dr. Arthur M. Corwin; secretary, Dr. Austin A. Hayden, 25 E. Washington St.

MARYLAND: The Section on Otology and Laryngology of the Baltimore City Medical Society meets at 8:30 p. m. on the last Friday of each month, at 1211 Cathedral St. Chairman, Dr. Edward A. Looper; secretary, Dr. Edwin N. Broyles, 1100 N. Charles St.

MISSOURI: The Kansas City Eye, Ear and Nose Society meets the third Thursday of each month from September to May. The November, January and March meetings are devoted to clinical work. President, Dr. Joseph W. Kimberlin; secretary, Dr. A. E. Eubank, 636 Argyle Bldg.

NEW YORK: The Section on Laryngology and Rhinology of the New York Academy of Medicine meets at 8:30 p. m. on the fourth Wednesday of the month from October to May, at 17 W. 43d St. Chairman, Dr. John E. Welch; secretary, Dr. Arthur Nilsen, 40 E. 41st St.

The Otological Section of New York Academy of Medicine meets on the second Friday of each month from October to May, at 103d St. and Fifth Ave. Chairman, Dr. J. L. Maybaum; secretary, Dr. R. T. Atkins, 4 W. 53d St.

OHIO: The Ophthalmological and Otolaryngological Section of the Cleveland Academy of Medicine meets on the fourth Friday of each month at the Winton Hotel. Chairman, Dr. W. J. Abbott; secretary, Dr. A. L. Stotter, 1148 Euclid Ave.

PENNSYLVANIA: The Section on Otology and Laryngology of the College of Physicians of Philadelphia meets at 8:30 p. m. on the third Wednesday of each month from October to June, at the College of Physicians. Chairman, Dr. Fielding O. Lewis; clerk, Dr. James A. Babbitt, 1912 Spruce St.

WISCONSIN: The Milwaukee Oto-Ophthalmic Society meets at 6:30 p. m. on the third Tuesday of the month, at the University Club. President, Dr. Charles J. Coffey; secretary-treasurer, Dr. Edward R. Ryan, 425 E. Water St.

Abstracts from Current Literature

Ear

PARACUSIS. VERN O. KNUDSEN and ISAAC H. JONES, Laryngoscope **36**:623 (Sept.) 1926.

It has been a common observation for more than one hundred and fifty years that many people appear to hear better when there is noise. This phenomenon, usually termed paracusis, has been noted not only by otologists, but also by patients themselves and the persons with whom they converse. The word paracusis literally indicates a perversion of the hearing function, but custom has limited the meaning of the term to the phenomenon of hearing better in a noisy place. Credit for the first description of this observation is attributed to Willis, and therefore has become to be known as "paracusis willisiana." Knudsen and Jones, by a series of experiments and careful observations, have endeavored to arrive at a more definite understanding of this condition. The usual explanation has been that the noise started the ossicles into gross vibration, thus enabling them to transmit the lesser vibrations which they otherwise could not transmit. Recently, the question has been raised as to whether these paracusic patients actually do hear better in a noise. The positive conviction of the patient himself has perhaps been the main reason for the general acceptance of the idea. It occurred to the authors that the answer to this question could be determined by experimental work.

In a series of 187 consecutive clinical records made with the audio-amplifier, the following classification was found: purely perceptive, seventy-three cases; mixed perceptive and conductive impairment, fifty-eight cases; purely conductive or almost entirely conductive impairment, fifty-six cases. In the seventy-three perceptive cases, no patient exhibited paracusis. In the fifty-eight mixed perceptive and conductive cases, fifteen of the patients exhibited paracusis, or about 25 per cent. In the fifty-six cases of conductive impairment, twenty-six of the patients exhibited paracusis, or about 46 per cent. Paracusis therefore appears to be a phenomenon associated with those having conductive impairment. Numerous and extensive tests were carried out on these various classes. The problem was investigated by two methods of approach: first, by determining the effect of noise on the acuity of hearing pure tones; second, by determining the interfering effect of noise on the hearing of speech sounds. The interfering effect of pure tones on the hearing of speech sounds also was determined. Normal persons were used as controls in all tests. The noise making apparatus was especially constructed to produce a noise that would contain all of the audible frequency components. It was equipped with a regulator and its intensity was measured in terms of sensation units. In the speech articulation tests, it was necessary that the caller should not hear the noise in order that the loudness of his speech would not be influenced. The results from the effect of noise on the minimal threshold for the hearing of pure tones revealed that the perceptive does not suffer any greater disturbance than does the normal person. The normal person was disturbed even more than the perceptive. In the paracusic patient the disturbance, both qualitatively and quantitatively, was the same as that produced on the normal or the perceptive person. The greater the noise the greater the effective diminution in the acuity for pure tones. There was no evidence to indicate that a noise of any magnitude occasioned an improvement in the acuity for tones. In all three types of

persons, the noise produced a masking effect on the tones, their loudness having to be increased before they could be heard. The paracusic patients did not exhibit a superior hearing acuity in the noise, but were subject to the same masking effects from it as the normal or the perceptive subjects were. Similar results were obtained from both the effect of noise and the effect of pure tones on the hearing of speech sounds.

The authors conclude that the question of paracusis, therefore, seemingly presents a paradox. The paracusic patient is himself convinced that he can hear better in a noisy place; his acquaintances all notice that he appears to hear better in a noisy place, and certain tests have shown that he does enjoy a peculiar advantage in the presence of a noise. In recognition of this, the authors advised one paracusic patient, a druggist, to move his office from a quiet location in the rear of his store to the front of the store, which faced the street in one of the noisiest parts of the city. Following this change he had much less difficulty in conversing with his customers. This relative advantage is explained by the fact that a noise is not so disturbing to the paracusic subject as it is to all other persons. The conductive type of hearing impairment is characterized by a much greater loss of acuity for the low frequencies than for the high frequencies and by comparatively good hearing for the medium frequencies, which is most important for the hearing of speech. Although ordinary noise is made up of frequencies throughout the entire audible range, a considerable portion of the energy of the noise lies in the frequency range below 512 double vibrations. As a paracusic person hears the tones below 512 double vibrations poorly, he is relatively less disturbed by them. The paracusic subject enjoys an additional advantage when conversing with a normal person or a person with perceptive deafness in the presence of a noise. The normal person always speaks louder in a noisy place because he hears the noise, is conscious of it and attempts to speak above it. This was confirmed by the authors' tests. When the noise was produced by a loud speaker, the caller noticed that he was speaking loud when the noise suddenly stopped. The paracusic subject does not hear the noise well; yet he hears his own voice abnormally well because of his conductive lesion. For this reason the paracusic subject does not speak loud in the presence of a noise. Therefore, the paracusic is getting the benefit of the louder speech, spoken by the normal person, whereas the normal person is attempting to hear the much feebler speech of the paracusic patient. This contributes greatly to the relative advantage enjoyed by the paracusic.

SNAPP, Grand Rapids, Mich.

MENINGITIS CAUSED BY STREPTOCOCCUS MUCOSUS. ERNST URBANTSCHITSCH, Ztschr. f. Hals-, Nasen- u. Ohrenh. **16**:129 (July 31) 1926.

Otitis caused by this bacillus is of little trouble to the patient compared with the otitis caused by other microbes. Yet slightly noticed symptoms may easily lead to a wrong diagnosis and treatment may be delayed until the seriousness of the situation is increased by a grave intracranial complication. Diagnosis is difficult because of the absence or the insignificance of otorrhea. In numerous cases, it is never present; in most cases, it lasts only from one to two days and is insignificant. In the great majority of cases, no perforation of the membrane of the ear drum is visible. This membrane is grayish pink and somewhat infiltrated; it bulges slightly or not at all. It sometimes presents the picture of a chronic catarrhal change. Frequently there are other symptoms, such as a decrease in hearing during some weeks, subjective sensations of hearing, and a feeling of dulness and the localization of Weber's test

in the diseased ear. These changes may also appear on the healthy side, because in chronic conditions similar changes are found bilaterally. In some cases the roentgenogram may help. There may be an absence of pain or of visible changes in the mastoid process, a normal or slightly elevated temperature and a somewhat disturbed general condition. *Streptococcus mucosus* meningitis is the result of no operation, operation too long delayed or postoperative complications.

Urbantschitsch gives the history of eight patients, of whom seven died, and cites a number of cases reported in the literature: three cases of Schmiegelow, five of Ruttin, three of O. Beck, one of O. Mayer, one of Leidler and one of Soyka. Of the twenty-two patients, twenty-one died. Eleven patients died within three days; of these, five died within twenty-four hours. One child, aged 13 months, suffered from meningitis for four weeks. The only surviving patient of Urbantschitsch was a child, aged 2 years. Patients with *Streptococcus mucosus* meningitis can be up and about and can even attend to business. Of the author's eight patients, two never had had a temperature as high as 98.6 F. The other five had only a moderate rise in temperature, mostly on two or three not successive days. Only the patients who recovered had high temperatures repeatedly. In six cases reported in the literature, the presence of a high temperature is noted. A local influence may have been present, because in different countries the disease may take a different course, or epidemic of grip may have existed. The presence of a thrombosis of the sinus may have been the cause of the rise in temperature. A surprising contrast exists between the clinical and the pathologic-anatomic observations.

In treatment, first, the mastoid process must be opened as soon as possible. In children during the first two years of life, Urbantschitsch opens both mastoids, even when there are no symptoms in one of the ears, because he finds that, at this age, *Streptococcus mucosus* infection is bilateral, although it may be of a different degree. This is caused by the width and shortness of the eustachian tube. It is better to err on the safe side. Besides surgical intervention in the ear, intralumbar treatment must be resorted to, especially by repeated spinal punctures. In spite of an existing meningitis, the spinal fluid may not contain any microbes. Antistreptococcic serum was used in two children. Theoretically, the success is doubtful, because *Streptococcus mucosus* belongs in the group of diplococci. Yet the two patients were benefited, although both suffered from exanthems. One patient had an exanthem three times (after three and after eleven days and after three months). Each time the temperature rose to 104 F. At present, Urbantschitsch tries bile acid. He thinks that it might perhaps be tried in connection with antistreptococcic serum in the spinal canal.

The first necessity is for an early diagnosis. The good result in one case was attributed to the operation which was performed before changes occurred in the membrane of the drum. Only the borderline between this membrane and the posterior upper wall of the meatus was indistinct, and some injection of the vessels could be noticed. The diagnosis was made by examination of the spinal fluid. Especially in children, an early spinal puncture is justified, and if the presence of *Streptococcus mucosus* is shown, a bilateral operation on the ears should follow, without regard to the condition of the membrane of the drum. The general practitioner and the pediatrician should consider the possibility of the presence of *Streptococcus mucosus* meningitis. No doubt more cases of this kind will be observed; perhaps the unpromising prognosis may be ameliorated.

CONSIDERATION OF TWO HUNDRED AND SIXTY-SIX CASES OF ACUTE MASTOIDITIS: THE QUESTION OF EARLY OPERATION. MAX BARWICH and WILHELM HAARDT, Ztschr. f. Hals-, Nasen- u. Ohrenh. **16**:325 (Oct. 14) 1926.

The general surgeon wonders why opinions of otologists differ when he is used to act according to the principle "Ubi pus, ibi evacua." The otologist knows the particular anatomic and pathologic-anatomic conditions of the mastoid process and knows that inflammations of the mastoid process take a different course from those in other bones. This is caused by the peculiar structure of the mastoid process and its close relation to the other parts of the organ of hearing and to the intracranial structures. One cannot draw far-reaching conclusions from single cases. Of the authors' 266 cases, 34 followed influenza, 12 measles, 1 scarlet fever, 5 endonasal operations, 2 trauma (1 followed the wound caused by a shrapnel shot and 1 a box on the ear). In the remaining cases, acute mastoiditis followed an angina or a coryza, or was apparently mastoiditis per se.

The organisms found in 266 patients were: *Streptococcus pyogenes,* 134 or 50.4 per cent; *Streptococcus mucosus,* 40 or 15 per cent; *Staphylococcus pyogenes,* 19 or 7.1 per cent; *Diplococcus pneumoniae,* 9 or 3.4 per cent; *Bacterium pneumoniae,* 2 or 0.8 per cent; *Bacterium coli,* 1 or 0.4 per cent; *Bacillus pyocyaneus,* 1 or 0.4 per cent; mixed infection, 8 or 3 per cent; sterile culture, 16 or 6 per cent; organisms unknown, 36 or 13.5 per cent.

Of 266 patients, 89.1 per cent were cured and 10.9 per cent died. Of the cured patients, 90.7 per cent did not have any complications. Of the patients who died, 86.2 per cent died of the ear disease and its complications, 13.8 per cent died of intercurrent diseases. The indications vary more or less with different authors. Koerner states that operation should not be postponed if it is probable that the bone of the mastoid process is diseased, and that a resorbable empyema is not present. It is better not to wait; delay not infrequently causes death. The earliest operation Koerner performed was on the sixteenth day. Boeninghaus follows the methods of Koerner and Schwartze. Heine, Alexander, Leidler and Krainz do not believe in early operations. Other authors are quoted. Dench, Strandberg and Plum believe in very early operation. The two latter endeavor to diagnose ostitis of the mastoid process as soon as possible, and then operate immediately. They assert that the diagnosis of otitis can, as a rule, be made during the first two to four days, and that they prevent intracranial complications and a chronic otitis by an early operation. O. Mayer stated that patients with a fulminating otitis media should be operated on on the third or fourth day, if tenderness and high fever do not decrease when there is a profuse discharge. Recently, Neumann and his school have stated that they believe in early operations in certain cases. The authors operate when evident clinical symptoms, lasting for several days, indicate that a suppuration exists in the mastoid process, without regard to the duration of the disease. They divide acute otitis media into three groups:

Group 1: The majority of cases of otitis in which, after a spontaneous perforation, or, after paracentesis, fever, pain in the mastoid process and subjective symptoms quickly disappear. In these cases operation may be delayed. In the majority, the condition disappears without operation. If mastoiditis develops, as a rule, it appears without violent symptoms during the third or fourth week.

Group 2: Cases in which, in spite of sufficient discharge, fever and pain of the mastoid process do not disappear during a few days, but increase. This means progress of the process, and operation must be performed immediately.

Group 3: The fulminating cases which can be observed especially during an epidemic of grip. This group is characterized especially by high fever, a grave general condition, pronounced pain in the mastoid process and eventually slight meningeal symptoms. These cases occur both in adults and in children. In order to discover or prevent grave complications in time, it is necessary to operate from some time between the third and the fifth day. Not infrequently, the authors have seen extradural abscesses, sinus and bulbus thromboses or acute labyrinthitis on the third day. If there is any suggestion of a complication (chill, vomiting, plain meningeal or labyrinthine symptoms), it is necessary to operate immediately. If severe symptoms are present without a perforated drum membrane and without any suggestion of complications, it is necessary to delay operation until the effect of paracentesis is observed. The authors claim that mastoiditis in old people frequently shows few symptoms.

The most constant objective symptoms of mastoiditis are tenderness on pressure, sagging of the posterior upper wall of the meatus, dulness on percussion (Koerner), a dark field on transillumination from the auditory canal and profuse suppuration. The canal which has been cleaned is filled with pus in from ten to fifteen minutes. Early operation has two advantages: First, the development of complications is avoided; second, existing complications are discovered early. The authors prove their assertions by case reports. The adversaries of an early operation assert that: (1) many patients would be operated on unnecessarily; (2) that in an early operation the bone disease could not be recognized in its totality, so that not all diseased bone could be removed and that a large defect would be created which would take a long time to heal; furthermore, that avenues to infection would be opened, and that it is doubtful whether complications could be avoided; (3) that the operation is technically difficult.

The first objection is met by the statement that in one fifth of the cases in which operation was performed early complications were found before or during the operation. The other objections are also met by the authors.

The surgeon must not stop the operation until he is convinced that he has opened even the smallest cell as far as it is possible. These cells must be sought with the chisel. In early operation, one cannot expect to be guided by pus emanating from cells or broken-down foci. Rapid operating is almost out of the question. Not infrequently an early operation lasts an hour or longer.

1. Acute mastoiditis must frequently be treated surgically on from the third to the fifth day, if certain exactly defined indications are present. 2. Early operation is indicated in cases which take a fulminating course, especially during an epidemic of grip. These cases can be recognized by the severity of the syndrome. 3. Early operation has important advantages. The only difficulty is that of technic; yet, the experienced surgeon should have no difficulty in this respect.

AMBERG, Detroit.

Pharynx

THE RADICAL CURE OF PERITONSILLAR ABSCESS. HARRY L. BAUM, Ann. Otol., Rhin. & Laryng. **35**:429 (June) 1926.

The usual treatment for peritonsillar abscess is disappointing, especially if the patient presents himself early in the progress of the disease. In view of the intense suffering involved and the many cases of serious and even fatal complications which have been reported, it is exceedingly desirable to afford relief as early as possible, rather than to wait until incision and evacuation are considered feasible. In order to accomplish this, Baum recommends the

removal of the tonsil in cases of peritonsillar abscess, thus obtaining a radical cure most satisfying to both the surgeon and the patient. The method is particularly adapted to the relief of second stage cases of the disease. In the late or third stage cases, the abscess is ready to rupture, and relief can be promptly obtained in the usual way.

Infection, penetrating the lining of the bottom of a crypt, migrates through the tonsillar capsule and becomes active in the potential space between the tonsil and the aponeurotic lining of the fossa. This may be termed the first stage of peritonsillar abscess formation, and may occur at any point on the capsular surface of the tonsil, usually near or above the center. The activity of the infection rapidly results in the formation of pus, thus forming the second stage of the process. The patient now begins to feel the definite signs of the disease, and examination reveals the tonsil pushed toward the midline with the beginning edema and dusky congestion of the mucosa. Pain and dysphagia are marked. Ordinary methods of approach will not evacuate the pus in this stage; therefore it becomes necessary to wait until expansion of the abscess in this limited space has resulted in migration upward around the upper pole of the tonsil in the areolar space in the palate. This is the third stage of the disease and usually occurs in from three to five days.

Drainage in the second stage is indicated, and the author believes that to secure that drainage tonsillectomy is necessary and advisable. The massive drainage secured by the removal of what really constitutes half the abscess wall practically obviates the danger of extension into uninfected tissue. The complete relief which results for the patient by this procedure is most gratifying. The patients rarely complain of a sore throat after operation, for the soreness causes little pain compared with the suffering incident to quinsy. The author always removes the normal tonsil at the same time without ill effect of any kind. Ether is recommended as a routine for this work, local anesthesia being both unsafe and inefficient. With careful suction the respiratory tract can be safeguarded against harm from aspiration of the pus.

PEMPHIGUS OF THE MOUTH AND PHARYNX. C. CALVIN FOX, Laryngoscope **36**:676 (Sept.) 1926.

Pemphigus beginning in the mouth and pharynx is a rare and usually a fatal disease. It resembles other infections of the mouth and throat for which the laryngologist is called on to treat patients, and the final diagnosis is uncertain, if not impossible, without the presence of skin lesions. Fox describes the course of the disease in some detail and reports a case. The condition is identical with pemphigus chronicus of the skin, differing only in that the site of the initial lesions is on the mucous membranes. The objective symptoms are fairly constant. Heat, moisture and trauma being constantly applied to the bullae, their thin epithelial cover ruptures quickly after formation and presents a yellow membrane soon surrounded by a narrow zone of low grade inflammation due to secondary infection. The initial lesions usually are found on the gums and closely resemble the familiar "canker sore," but soon become general and coalesce, including large areas of the mucous membrane. There is a marked increase in the flow of saliva, and sometimes a repulsive, putrid odor is present. The parotid duct may become infected and the ostium swollen shut, causing retention and swelling. When the base of the tongue and larynx become involved, swallowing causes much pain and agony. The patient becomes depressed, nervous, apprehensive and sensitive because of the offensive nature of the disease.

The etiology is still an unsolved problem. Many theories have been advanced on this point, one of the commonest being that the disease is of bacterial origin. Eberson asserts that he has found a gram-positive, anaerobic, nonmotile, coccoid or ovoid organism in the blood in seven cases. Cultures from primary unruptured blebs are sterile. The prognosis is unfavorable, the result practically always being fatal when the mucous membranes are markedly involved. The treatment is supportive with concentrated liquids and soft foods. The intramuscular injection of arsenicals is always considered advisable. The subcutaneous administration of coagulen on alternate days is said to enhance the value of arsenical medication. A mouth wash containing resorcin and myrrh is often beneficial.

SNAPP, Grand Rapids, Mich.

Larynx

PHOTOGRAPHY OF THE INTERIOR OF THE LARYNX BY THE STRUYCKEN LARYNGOSCOPE. STRUYCKEN, Ztschr. f. Hals-, Nasen- u. Ohrenh. **14**:618 (June 12) 1926.

Before Struycken laryngoscope is used, it is necessary to practice its manipulation and its introduction. Photographs should then be taken on a cadaver in order to learn the degree and the time of illumination, and to acquire the necessary skill. When the glottis is focused, the light is turned on until it shows red, the room is moderately darkened and the heated camera is put in place. It takes a little time to reach the photochemic efficiency of the lamp. The following steps should be considered: (1) introduction of the laryngoscope; (2) focusing of the glottis and fixation with the breast stem; (3) turning on of the light to red heat and darkening of the room; (4) adjustment of the camera and pressure on the bulb; (5) shifting of the camera, control of the clear presentation, and placing of the new film in postion.

TREATMENT OF STENOSIS OF THE LARYNX AND TRACHEA. W. UFFENORDE, Ztschr. f. Hals-, Nasen- u. Ohrenh. **14**:625 (June 12) 1926.

Brueggemann's cannula has all the advantages for the treatment of stenoses of the larynx and the trachea which can be expected of instruments made of metal; yet there is no instrument which can be used under all circumstances with equal advantages. Cannulas made of rubber are more useful in some cases. Uffenorde describes a case of laryngofissure with excision of the left arytenoid cartilage. The patient, aged 16, had been admitted to the clinic on account of increasing dyspnea and stridor. When he was 2½ years old, he had suffered from pharyngeal and laryngeal diphtheria which had necessitated a tracheotomy. The wound had remained open until the patient was 4 years old. On account of difficulty in breathing, attempts had been made to dilate the trachea from above. Stridor had always been present, which could be heard all over the patient's home. Uffenorde was obliged to remove Brueggemann's cannula on account of pain while swallowing and on account of pressure symptoms with necrosis and infection. Uffenorde wanted to avoid further decubitus and introduced a soft red rubber drainage tube. The tube reached from the superior thyro-arytenoid ligaments beyond the stenosis, and was held in place by linen tape 2 cm. in width, which was secured by stitches of aluminum bronze wire. Uffenorde brought the tape from the rear of the cannula around the drainage tube. The "reins" should always lead from the sides of the tube in order to have some effect on the edges of the wound. The irritation of the posterior wall of the trachea can be eliminated by a coating with gutta-percha solution in chloroform (Kuemmel). The cannula was changed frequently; later it was

left in place for several weeks. Five weeks after the operation the use of the tube could be discontinued. The tracheal channel of the larynx was sufficiently wide and smoothly epidermatized so that the patient could breathe easily for a long time after the opening in the trachea had been closed. The author claims his method is superior to that of Schmiegelow, as according to his method the tube can easily be removed in cases of emergency. The simple straight rubber tube cannot be used in children up to 2 or 3 years of age on account of the narrowness of the lumen. In these instances Brueggemann's method should be employed.

Uffenorde then considers the acute forms of stenosis in the traumatic cases. Only those are considered in which the cartilaginous structures are injured. Changes confined to the mucous membrane (hematoma, emphysema, edema and submucous inflammations) may heal after tracheotomy. If fractures of the larynx are associated with disturbances of the mucous membrane, one must wait before deciding which procedure to use. By the introduction of the cannula, the fractured and deformed parts should be brought into the right position and kept there. Roentgenograms are used for control. If the mucous membrane is preserved satisfactorily, Brueggemann's cannula may be used. If a suppurative inflammation or perichondritis is present, it should not be used. In the latter instance a rubber tube, rubber sponges, etc., are in order.

Frequently the metal cannula is well borne. If that is not the case, it can be removed after a few days and can be reintroduced when the irritation has disappeared. Uffenorde mentions a case in point. A boy, aged 2 years, on Dec. 27, 1925, drank hot coffee from the spout of a can. Eight hours later, under unfavorable conditions, a high tracheotomy and cricothyreotomy were performed. The cannula could not be removed after eight days. On admission, severe inflammation in the larynx and trachea and a large, gaping thyreotracheotomy wound with deformation and changes of the larynx could be seen. A soft rubber drain could not be introduced; therefore a simple cannula was put in place. After the wound had become somewhat cleaner, a Brueggemann cannula was inserted. This had to be removed after two days on account of difficulty in swallowing, refusal to take nourishment and reappearance of a rise in temperature. After three days the cannula was reinserted, and two days later it was removed on account of reappearance of the same difficulties. This change was repeated twice. At last, after twelve days, the cannula was introduced for three weeks without further disturbance. On Feb. 25, 1926, the cannula was finally withdrawn.

These rare cases usually end fatally. Mackenzie has observed many cases of this kind in England. "Children who are allowed to drink from the spout of a teacan repeat this procedure while the teakettle is boiling. After from two to three hours the larynx becomes edematous." Pitts reported (*British Medical Journal*, 1893, p. 105) seventy-eight cases which had been observed in the St. Thomas hospital during twenty-one years. Of eighteen patients with fatal outcome twelve had to submit to a tracheotomy. Uffenorde observed a few such patients who recovered without surgical intervention. Another patient, aged 4½ years, who drank boiling milk, died with symptoms of lung trouble in the pediatric clinic of the university of Marburg (Professor Freudenberg).

Necropsy showed pleuritis with foci of pneumonia on the right side. Grayish white coating was found on the tip of the tongue. The mucous membrane of the pharynx was red and covered with thick, removable coating. This was also found at the entrance of the larynx, stopping abruptly at the vocal cords. The mucous membrane of the trachea and of the large bronchi was red, while it was whitish in the esophagus. The surface of the lungs showed red macula-

tions the size of a lentil, under which the lung tissue was inflamed. Some cloudy, grayish yellow fluid was found in the large bronchi. Uffenorde cites another case. A child, aged 2 years, admitted to the pediatric clinic of the university, had drunk hot coffee from a coffee pot on the morning of Dec. 2, 1924. The child died, December 3, at 2:55 p. m., with the symptoms of severe toxic hyperpnea. The Trousseau phenomenon was always negative. There were slight spasms in the left hand. The grave acidosis which had existed in the morning had receded by noon. The necropsy revealed dirty yellowish coating of the pharynx, tonsils, uvula and epiglottis. The mucous membrane of the epiglottis was destroyed. The hyoid bone was bare on the left side. The esophagus showed no change. Foci of pneumonia were found in both lower lobes of the lungs and in the posterior part of the right upper lobe.

Reverting to the usefulness of the rubber cannula, Uffenorde states that it can easily be made and that it can be changed by the nurse or even by the patient. When one patient was sent home, he was given an extra cannula. The system worked well. In a similar way, a rubber drainage tube was used successfully in a patient with a grave case of tuberculosis of the larynx who had submitted to a tracheotomy and who could not endure the cannula.

ANATOMY AND THERAPY OF CARTILAGINOUS TUMORS OF THE LARYNX. G. ENGELHARDT, Ztschr. f. Hals-, Nasen- u. Ohrenh. **16**:77 (July 31) 1926.

The anatomy and therapy of cartilaginous tumors of the larynx are still undetermined. It is possible to distinguish between ecchondromas, which are benign and do not return, chondromas, which can become malignant under certain circumstances, and mixed tumors, which are obviously malignant and require radical intervention. As the classification of these tumors is of importance for therapeutic purposes, the question presents itself whether a pathologic-anatomic difference exists between an ecchondroma that has a broad base and chondroma.

Different varieties of cartilage, mucous tissue and bone may develop from cartilage or metaplastically from calcified connective tissue. This is brought about by the circumstance that a nondifferentiated layer of connective tissue which has possibilities of differentiation may become active. Dreyfuss, in 1916, and the author, in 1926, came to the conclusion that a differentiation between ecchondroma and chrondroma is not justified.

Dreyfuss (Bruns' Beitr. z. Klin. Chir., 1926, vol. 37) states that chondromas of the larynx develop from cartilaginous layers that have been left. The ossification is accomplished in the fifth decade. In view of the fact that only the cricoid cartilage carries the cartilaginous tumor, it must be assumed that chondromas develop from rests of cartilage which should have been ossified long before, but which have remained quiescent in development and have received a new impetus to grow; these do not now ossify but show an excessive growth as cartilage (Dreyfuss). Real myxomas do not occur in the larynx.

The diagnosis of mixed tumors demands a great deal of experience. The proof of numerous mitoses is important. It is frequently difficult to establish malignancy from miscroscopic observations, and it can be done only by a pathologist who is an authority on tumors. The clinician does not need the pathologist when obvious changes are present, such as grapelike masses of tumor, destruction of cartilaginous tissue without ossification or growth of the tumor through the cricothyroid membrane. Yet it must be remembered that a moderate distention of cartilage and formation of cysts cannot be taken per se as signs of malignancy. The hypertrophy of the cartilaginous tissue

of the larynx is not a tumor (Alexander). Alexander, in 1900, recognized the importance of roentgen-ray examination in connection with tumors of the larynx. The direct examination of the larynx is of value.

Cone-shaped cartilaginous growths at the arytenoid and the thyroid cartilages should be left alone if they do not show any tendency to grow or do not affect the voice. Endolaryngeal removal of a small cartilaginous growth at the attachment of, or below, the vocal cord was not successful; a disturbance of function remained. Cartilaginous tumors with a broad base, whether they are enchondromas or chondromas, demand a conservative laryngofissure if a mixed tumor is not present; i. e., removal to the level of the cricoid or thyroid cartilage without considering whether rests of ossified or regressively changed cartilaginous tissue remain. Saving of the mucous membrane when these tumors are present is not of any consequence. When the tumors are small, a preliminary tracheotomy is not indicated. Since the introduction of local anesthesia, better results have been obtained.

In cases of ecchondromas and chondromas, one should be as conservative as possible because a differential diagnosis is not possible, from either a pathologic-anatomic or a clinical standpoint. In mixed tumors, no compromise is possible. The success of endolaryngeal treatment and of partial resection is doubtful. Only in Bond's patient has a favorable result been reported in regard to function. In partial resection, better results are obtained when one or both thyroid cartilages are resected than when the cricoid cartilage is resected. If a cartilaginous tumor extends beyond the larynx, only total extirpation can be advised (Hajek). The main responsibility in cases of these tumors rests with the pathologist.

MYOPATHIC PARALYSIS OF THE LARYNX AND ROSENBACH-SEMON'S LAW. KARL WILHELM CLAUBERG, Ztschr. f. Hals-, Nasen- u. Ohrenh. **16**:299 (Sept. 22) 1926.

A sharp distinction between neuropathic and myopathic paralysis of the larynx has been considered impossible. Only in trichinosis, in tuberculosis and in waxy degeneration in typhoid fever, have purely myopathic forms been recognized. Rehn was of the opinion that the isolated paralysis of the posterior crico-arytenoid muscle was caused by degeneration of the muscle. In single instances, Hart saw isolated Zenker's waxy degeneration of the muscles in patients who had died of typhoid fever and of tetany. Clauberg resorted to animal experimentation. He subjected guinea-pigs to infection, intoxication with poisons producing convulsions and to an anaphylactic shock. The results were negative. Hart assumed that chemicotoxic and mechanical irritation (abnormally strong and irregular contractions) caused changes in the posterior crico-arytenoid muscle because the increased amount of blood carried more toxins to the muscle, and that this circumstance, added to the violent contractions caused by dyspnea, led to stratified decomposure. Clauberg went further and concluded, on the basis of Hart's ideas, that injuries caused by intoxication should present themselves as waxy degeneration not only in this muscle but also in the whole area.

Therefore, fresh specimens taken from cadavers not older than 24 hours were obtained by picking tissue from the muscles of one side of the larynx and from as many corresponding muscles as possible of the other side. In grave diseases, compared with other muscles of the body, the muscles of the larynx, especially the posterior crico-arytenoid muscles, showed cloudy swelling and degeneration with fat deposits. Besides fifty specimens of tuberculosis

of the larynx, a number of patients with sepsis (one with Friedländer's bacillus) were examined, also specimens in several cases of generalized carcinosis, diffuse suppurative peritonitis, lobar pneumonia, a phlegmon of the throat and from several patients who had been poisoned (among them one with mercury and one with illuminating gas). All showed a similar picture. When the changes were pronounced, disturbances of inspiration and changes of the voice had been present during life. The myopathic paralysis of the larynx seems to be much more frequent than is generally supposed. The preferred localization in one muscle can more easily be explained by considering it myogenous. The Rosenbach-Semon Law is satisfactorily and simply explained by the proofs of the author, which are a generalization of the ideas of Hart.

AMBERG, Detroit.

Nose

CHEMISTRY OF THE BLOOD IN OZENA. OTTO FLEISCHMANN, Ztschr. f. Hals-, Nasen- u. Ohrenh. **14**:587 (June 12) 1926.

Anomalies of the skeleton have been assumed by some investigators to be the etiologic factor in ozena. Anomalies of the skull, and especially of the nose, have been described by Zaufal, Bergeat, Hartmann, Hofmann, Kayser, Siebenmann, Haike and others. Kayser and Siebenmann found that brachycephalic and platyrrhinic persons are affected most often, but A. Alexander found that ozena is most prevalent in Spain in persons of the predominating dolichocephalic type, while it is rare in the pug-nosed natives of New Guinea and the platyrrhinic negroes of Africa and Australia. Some rather frequent observations in ozena, however, cannot be considered as incidental; namely, missing or undeveloped nasal accessory cavities, a shortened septum and a widened and shortened palate, as well as atrophy of the bone, which is found only rarely.

The absence of some accessory cavities is rare. With regard to the frontal sinus, A. Onodi demonstrated that roentgenograms of 1,200 skulls showed the absence of both frontal sinuses in only 5 per cent and absence of one frontal sinus in not 1 per cent. He confirmed the observations of Boege and Oppikofer. In necropsies on five subjects with ozena, Minder twice found absence of both frontal sinuses, and Haike found only two normal frontal sinuses; they were absent nine times and eleven times their development was rudimentary in thirteen patients who had suffered from ozena since childhood. According to Elmiger, peculiarities of the septum and palate are also found in leptoprosopic as well as in chameprosopic patients. According to Potiguet, A. Alexander and Cisler, the peculiarities of the skull in patients with ozena occur through a lack of development of the skull caused by the disease. Ozena is frequently associated with congenital changes such as anhidrosis, hypodontosis and hypotrichosis, which constitute defects of the ectoderm (Christ and Nager). Relations between ozena and the endocrine system are of a too indefinite nature. Christ, Halphen and Schulmann assert that there is a relation between ozena and disturbances of the sympathetic nervous system, and Worms states that there is a similar relation between paralysis of the trigeminal nerve and ozena. These relations are problematic. The improvement which Halphen and Schulmann said was obtained by injection of epinephrin, hydrochloride hypophysin and pilocarpine must be attributed to the activating of the protoplasm, the effect being similar to that of protein therapy. It is doubtful that the disease is hereditary and familial, although Sachs found this in 35 per cent of the cases, Busacca in 42 per cent and Perez in 77 per cent. Perez and Hofer,

however, assume the presence of familial infection, yet various authors have reported cases which make this view doubtful. Regarding hereditary influences, it must be mentioned that investigations by Ascher, Loewy and Wechselmann showed these to be present in anomalies of the ectoderm. The preponderance of a constitutional etiology is more acceptable to Fleischmann than the theory of infection of Perez and Hofer, which is considered untenable. Fleischmann studied the chemistry of blood in ozena. The blood was obtained by venipuncture in the morning, before breakfast. The amount of cholesterin was found diminished in ozena (normally from 120 to 180 mg. per hundred cubic centimeters). The more recent process showed the smallest amount.

The relationship between ozena and lipoid phosphorus is not so plain, yet in all cases of atrophic rhinitis a decrease of cholesterin is found. Ozena and atrophic rhinitis differ only in degree, not in principle. Lecithin plays a greater part than cholesterin in simple and fetid rhinitis. In this group of diseases a certain density of the cell membrane exists. This affects the exchange of tissue, fluid and blood, and an increased activity of the secreting cells follows. Yet the relationship of potassium to calcium, and of globulin to fibrinogen-albumin also must be considered. The first relationship shows normal conditions. The second was not investigated by Fleischmann. Pollack, however, showed that the fibrin content of blood in ozena presented an increase of 100 per cent. This points to an increased permeability, by which the effect of the preponderance of lecithin is still more increased. Scarcity of cholesterin results in shifting of the acid-base equilibrium to the acid side (Krauss and Zondek), which still more predisposes the tissue to infection. Therefore the chronicity of a nasal suppuration in atrophic forms must be attributed to these disturbances of metabolism.

When ozena progresses, the discharge decreases (Lautenschlaeger). It runs parallel with the cholesterin content of the blood which increases with the duration of the process. Therefore it is unnecessary to say that a specific infection or inflammation of the accessory cavities in childhood explains the hypertrophic or atrophic stages of ozena. A small amount of cholesterin indicates atrophic changes. Cholesterin is a protective agent against various influences which destroy cells (Rubner). What is the nature of these influences? Although Fleischmann does not deny a bacterial toxic influence in the course of ozena, he places it in the second or third place with regard to its importance. The influence leading to atrophy must be of a different nature. Oxidative injuries of the cell through lack of cholesterin and the subsequent lack of density of the cell membrane cannot be denied. Leupold and Bogendoerfer have shown that animals can be immunized against an infection by an artificial hypercholesteremia. Control animals died. This explains why in ozena the nose becomes the breeding place for all kinds of microbes which never develop otherwise, or which develop only under certain conditions. This makes the supposed bacterial etiology doubtful (Abel, Loewenberg, Perez, Shiga, Tassi and Nasso, and others). The amount of cholesterin can be increased by vaccine therapy. The scarcity of sweat glands and of all other skin glands also points to the constitutional character of ozena. The activity of certain micro-organisms also suggests itself. Research has not yet been made concerning the cholesterin content of the blood in patients who lack sweat glands. Possibly a relation may exist between the head in a subject with ozena and a lack of cholesterin. In rats fed with food rich in carbohydrates but poor in fat, Dean observed a retarded development of the accessory cavities as well as inflammatory conditions in the nose. Can there be a lack of cholesterin in later life? People in poor economic circumstances and people with certain

occupations are more severely affected than others, for instance, shoemakers, harness makers and washerwomen. Grave cachetic disturbances frequently lead to an impoverishment of cholesterin (Hueck), also to grave anemic conditions (Medak, Pribram, Strauss and Schubert).

Whether undernourishment leads to hypocholesteremia is questionable. Patow observed that the number of persons with atrophic processes of the nose doubled during the time the Russians were undernourished.

THE BLEEDING POLYP OF THE SEPTUM. WILHELM SCHREYER, Ztschr. f. Hals-, Nasen- u. Ohrenh. **16**:41 (July 31) 1926.

The polyp of the septum is an angioma, fibroma or granuloma. Benjamin observed polyps of the septum caused by a certain parasite in tropical countries. He found sporoblasts of *Rhinosporidium Seebergi*. Passow considered the polyp of the septum to be a tumor-like formation which develops on an inflammatory base, for instance, after an anterior rhinitis sicca. Glas tries to prove the unity histologically of anterior rhinitis sicca and polyp of the septum. In both he found metaplasia of the epithelium and a substance in the mucosa which resembles keratohyaline, hyaline degeneration of the interstitial connective tissue and accumulation of pigment, an abundance of eosinophils and plasma cells and atrophy of the subepithelial connective tissue. Glas thinks that the inflammatory nature of the polyp is proved by the histologic observations, by the numerous mast and plasma cells, the great number of fibroplastic elements, the formation of a superficial pseudomembrane and the intra-epithelial accumulation of leukocytes. The polyps of the septum are formed by a combination of three different tissue parts, according to Glas: (*a*) a portion resembling granuloma fibroblasts with many round cells, (*b*) a polypoid portion as in edematous polyps of the nose and (*c*) an angiomatous portion.

Other authors think that polyps of the septum are real tumors (Trautmann and others), and consider them to be cavernomas or hemiangiomas or teleangiectatic angiomas. According to Katz, the polyp of the septum is a variation of the angioma, a mixed form consisting of blood vessels and tissues found in the mother soil, which tend toward increased growth. This mother soil is the mucous membrane of the septum and consists of a ground substance of connective tissue and glands. It may be an angiofibroma or an angio-adenofibroma or an angio-adenoma. Schreyer states that undoubted angiomas have repeatedly been observed at the anterior portion of the septum. It is possible to trace the lymphocytes in polyps of the septum from adventitial cells. Herzog considers the adventitial cells a potent germinal tissue, differentiated by various causes, and which forms the matrix of all mesodermal connective tissue tumors. He refuses to make a sharp distinction between fibromas, hemangiomas, endotheliomas and even sarcomas, because all apparently originate from the adventitial cells.

Schreyer examined thirteen polyps of the septum in the clinic in Breslau and came to the conclusion that polyps of the septum are abnormally proliferating angiomas. Schreyer also describes the telangiectatic granulomas and angiomas of the mucous membrane of the mouth. As a therapeutic measure, Schreyer recommends excision of the adjacent mucous membrane of the septum and escharation or cauterization of the spot of attachment to prevent recurrences. The author does not believe that these formations are of an inflammatory nature and considers them abnormally proliferating angiomas which become ulcerated on the surface and secondarily inflamed.

A New Method of Conduction Anesthesia of the Second Branch of the Trigeminus. M. Slobodnic, Ztschr. f. Hals-, Nasen- u. Ohrenh. **16**:86 (July 31) 1926.

Conduction anesthesia in operations on the nose and the accessory sinuses has found few adherents because the known methods cannot be used easily, and because the nose is innervated by two separate branches. The author describes a method which he asserts is of value for the surgeon and the dentist as well. The first branch of the trigeminus nerve, the ophthalmic nerve, innervates the mucous membrane of the anterior portion of the septum, the anterior portion of the lateral wall of the nasal cavity, the anterior and posterior ethmoid cells and the sphenoid. The second branch, the maxillary nerve, innervates the upper teeth, the gum, the bone and the mucous membrane of the maxillary antrum, the ethmoid cells and the sphenoid, the upper middle and the lower parts of the turbinate, the nasopharynx, the pharyngeal orifice of the eustachian tube, the middle and posterior parts of the nasal septum and the hard and the soft palates. Only the second branch of the trigeminus affects the pterygopalatine fossa.

Three questions arise concerning conduction anesthesia in the pterygopalatine fossa:

In which operations of the nose and its accessory cavities does the interruption in the pterygopalatine fossa alone suffice to produce the desired anesthesia, and in which operations is interruption useful as an auxiliary measure in this region? What advantages has interruption in the pterygopalatine fossa compared with other methods of anesthesia? What advantages has the method proposed by the author?

Interruption alone suffices for operations on the maxillary sinuses, in the nasopharynx, the posterior part of the nose and the palate process and the alveoli. As an auxiliary method, conduction anesthesia must be considered in regions in which the nerve supply is mixed, for instance in the ethmoid cells, the sphenoid and the frontal sinus.

Extremely small quantities of anesthetizing fluid are necessary for conduction anesthesia in the pterygopalatine fossa. In a radical operation of the maxillary sinus (Caldwell-Luc) the author uses 6 cc. of a 1 per cent procaine solution mixed with epinephrine hydrochloride (amount of epinephrine not stated), 4 cc. for the pterygopalatine fossa, 2 cc. for the infra-orbital nerve, and a few drops of a 10 per cent cocaine solution for painting the lower nasal meatus. An added advantage is the presence of the anemia, which allows a better view of the operative field.

Braun, Mathas, Haertel, Offerhaus, Schloesser and others have advocated various points for the introduction of the cannula; for instance, the middle of the upper border of the zygoma, the middle of the lower border and the point where the zygoma meets the upper maxilla. Haertel and Schloesser proposed the anesthetizing of the gasserian ganglion (through the round or oval foramen). In another method of anesthetizing the gasserian ganglion through the foramen rotundum a passage through the orbit is used. Sluder suggested anesthesia of the sphenopalatine ganglion through the middle nasal meatus. Recently, Reddingius suggested a method used previously by dentists (Fischer, Carrer); namely, the anesthetizing of the pterygopalatine fossa through the foramen palatinum majus and the canalis pterygopalatinus. All four routes are fraught with danger. In one method the needle may enter the brain or sinus, in the other the eyeball or the optic nerve may be injured. Sluder's method is technically difficult. The method has the drawback that the pterygo-

palatine channel is narrow and that the cannula may break, especially if the mouth is small. All methods are less effective when pronounced anatomic variations are present. The author proposes an easy method devoid of danger. He thinks that the easiest way to anesthetize the second branch of the fifth nerve is to approach the pterygopalatine fossa from the posterior wall of the upper maxillary process. After painting the fold between the cheek and the gingiva behind the last upper molar with a 10 per cent cocaine-epinephrine solution and some iodine, a specially constructed cannula that fits any record syringe is introduced from the mouth in the niche between the cheek and the posterior end of the upper alveolar and pterygoid process. The cannula consists of two parts, a straight tube 8 cm. in length with a mark for orientation, and a second thinner, semicircular piece. The thickened free end of the cannula is held downward and outward, so that the inner end points upward and inward in a line with the facies infratemporalis maxillae in front of the pterygoid process, in the sulcus between the maxillary bone and the pterygoid process. The cannula passes along the posterior wall of the maxillary bone without pressure upward to the pterygopalatine fossa, where it moves freely. Then the cannula is turned around its axis inward and is advanced gradually and slowly until pain in the upper teeth or on the corresponding side of the face proves that the nerve is touched. It is sufficient to introduce the anesthetic perineurally. Before injecting the anesthetic it is necessary to be convinced that the needle has not entered a blood vessel. The author uses from 2 to 8 cc. of a 1 per cent procaine solution with the usual quantity of epinephrine hydrochloride, according to Denker. The author has used his method successfully in more than 100 cases. The method is used in radical operations of the maxillary sinus, according to Caldwell-Luc; in radical operations of the ethmoid cells; in operations of the sphenoid, in external radical operations of the frontal sinus; in operations for ozena, according to Halle and Lautenschlaeger, in removal of the posterior ends of the turbinates and submucous resections of the septum, in closing fistulas after operations on the maxillary sinus; in the extraction of teeth in the upper maxilla; in neuralgias of the second branch of the fifth nerve, and in vasomotor rhinitis.

For operations on regions of the nose which are innervated by the first branch of the fifth nerve, the author's method should be supplemented by the usual methods of anesthetizing. From ten to twenty minutes after the injection, the maximum effect is reached. It lasts from one to two hours. In rare cases a complete anesthesia is obtained for regions supplied by the posterior nasal, nasopalatine and palatine nerves, but only a diminution of sensitiveness to pain for parts innervated by the infra-orbital nerve. In these rare cases an endoneural injection of the infra-orbital nerve is necessary at its exit from the oral cavity with from 2 to 3 cc. of anesthetizing fluid. This is probably necessary when the infra-orbital nerve is situated especially deep in the pterygopalatine fossa. The author had no disagreeable experiences.

Importance and Development of a Peculiar Discoloration of the Nasal Mucous Membrane in Bronchial Asthma, Nasal Asthma, Vasomotor Rhinitis and Other Reflex Neuroses of the Nose. W. Undritz, Ztschr. f. Hals-, Nasen- u. Ohrenh. **16**:149 (Sept. 22) 1926.

Vasomotor symptoms of the mucous membrane of the nose and the respiratory tract have frequently been observed in patients with asthma during the attack. Yet between attacks also the nasal mucous membrane of most asthmatic patients gives a characteristic picture. It does not present the

ordinary red or yellowish red color, but sometimes a peculiar white, which resembles a mucous membrane treated with epinephrine. These white and bluish white spots were first described by Prof. W. Wojatschek, and were correlated by him to the syndrome of bronchial asthma. The white spots in asthma develop through vasomotor disturbances, which cause a long vessel spasm. These vasomotor disturbances cannot be explained by an isolated stimulating tonus of the sympathetic or parasympathetic system, because neither the experiment nor clinical investigations bear out this view. The white spots can be correlated to the labile neurotonus of the vegetative system. Pharmacologic tests in asthmatic patients show that this condition exists in the vegetative nervous system. The white spots are first caused only by functional disturbances, but later anatomic changes also are found in the mucous membrane. The anatomic changes consist mainly of metaplasia of the epithelium, of disturbance of the secretion of the glands and of thickening of the membrana limitans. Frequently, traces of a chronic inflammation are found which may lead to a fibrous change of tissue. The basis of bronchial asthma is hereditary. A general neuro-arthritic constitution usually is present, combined with a local atrophic constitution of the nasal mucous membrane. The hyperirritability by proteins and other symptoms of asthma discovered by modern investigation develop mostly on such a foundation. The whitish blue spots on the nasal mucous membrane described by Wojatschek are the sign of bronchial asthma and similar conditions.

AMBERG, Detroit.

Miscellaneous

COMMENT ON ARTICLE OF SCHEIBE: "MY DOCTRINE OF THE EMPYEMA: WARNING CONCERNING THE TERM MASTOIDITIS." JOSEF BECK, Ztschr. f. Hals-, Nasen- u. Ohrenh. **16**:56 (July 31) 1926.

As a rule, bone apposition is the first inflammatory reaction of the bone. Yet this stage may be skipped or may not be demonstrable because newly formed bone may be resorbed exactly like old bone. Beck agrees with Krainz that as a rule inflammatory processes start earlier in the marrow spaces than in the pneumatic cells.

MASTOIDITIS AND EMPYEMA. ANSWER TO SCHEIBE: MY DOCTRINE OF EMPYEMA; WARNING AS TO THE TERM "MASTOIDITIS." H. HERZOG and W. KRAINZ, Ztschr. f. Hals-, Nasen- u. Ohrenh. **16**:58 (July 31) 1926.

This article is an exhaustive answer to some of Scheibe's views. Scheibe believes that disease of the mastoid process begins in the pneumatic cell. According to Scheibe, "the primary cause is the empyema, i. e., the absolute or relative occlusion of the neck of a suppurating cell by its covering, which is reactively swollen." This is supposed to result in a retention of pus, hyperpressure, rarefaction of the bone and eccentric dilatation of the cavity, which cause the formation of a fistula. Herzog and Krainz believe that they have proved that the first signs of the bone disease are found in the channels of the vessels and small marrow spaces, and that the disease begins as a consequence of increased pressure in the vessel system in the form of cellular and vascular osteoclasia. Furthermore, they believe that they have proved that the pneumatic spaces become diseased secondarily and that the empyema is not the essential phenomenon, but only a complication, a symptom among several others. The authors also affirm that the same process of bone resorption occurs in true acute otitis media in a spongy mastoid process without pneuma-

tization. The clinical symptoms (tenderness on pressure, edema) frequently do not allow any doubt that the inflammation has progressed from the depth of the middle ear outwardly. The pathologic-anatomic cause is unknown. In a given case, it is unknown whether an inflammatory edema of the outer covering is present, whether a serous or purulent exudation has taken place in the cavities, or whether a reactive process has begun in the bone. Pain and tenderness lasting for some time suggest that an inflammatory condition is present, and yet this may occasionally recede. In answering Scheibe the authors assert that they did not use pieces of bone without choice; they consider their material comprehensive. They agree with Scheibe that the difference in the basis of investigation led to contradictory results.

Unlike Scheibe, the authors declare that the inflammation of the mastoid process is principally identical with inflammations in other parts of the body, and they adhere to the term "mastoiditis." The term "endostitis" is based on observations made in former investigations. The pneumatic cells are covered by endosteum. This covering is neither a "continuation" of the pharyngeal mucous membrane nor a mucous membrane. Only the epithelium extends from the pharynx into the mastoid cells with changes of shape and function becoming what is called epithelium pneumaticum. Also, the marrow spaces are covered by endosteum, according to Schaffer and Ssamoylenko.

COMMENT ON THE SO-CALLED OSTEOPOROSIS OF THE "SPONGELIKE CHANGES OF THE MASTOID PROCESS" OF PROFESSOR SCHEIBE. G. POMMER, Ztschr. f. Hals-, Nasen- u. Ohrenh. **16**:68 (July 31) 1926.

A. Scheibe asserts that resorption of bone is present when there is swelling of the Sharpey's fibers that are not calcified and widening of the channels. Schmorl, however, declares that he is unwilling to state definitely that Sharpey's fibers are changed by inflammation. He says that a swelling may perhaps be present, but that he has found it only exceptionally. Pommer enters into an exhaustive discussion of the subject. This must be read in the original. He says that Scheibe is in error if he believes that absence of osteoclastic cell activity in dental caries, i. e., caries of dentin and enamel, weakens the opposition to his view concerning the hypothesis of resorption in the inflammatory swelling of Sharpey's fibers. The chemic parasitotrope of dental caries differs from the observations in osteoclastic bone resorption and from Scheibe's description of the supposedly bone resorbing Sharpey's fibers. In caries of the teeth there are vegetable growths and *Bacillus acedophilus-odontolyticus,* associated with streptococci and other organisms (Miller, 1892, Gowbys, 1900, L. Heims, James McIntosh, W. Warwick, James and P. Lazarus-Barlow).

SURGICAL TREATMENT OF DENTAL CYSTS. H. LOEBELL, Ztschr. f. Hals-, Nasen- u. Ohrenh. **16**:91 (July 31) 1926.

After surgical intervention it is necessary that the tooth leading from the cyst should be cared for by the dentist.

Control of the neighboring teeth with a faradic current is also necessary after operation.

All small cysts and cysts of the lower jaw should be cared for by the dentist.

Every cyst must be operated on, because treatment of the tooth alone is not sufficient.

The part of the cyst wall which protects the teeth should be spared as much as possible.

In two cases the course after operation, according to the method of Partsch, was studied histologically to learn choice of procedure. The method of Partsch is used by dentists almost exclusively. In the two cases studied the shrinkage of the cyst could be shown in the structure of the bone and in the thickening of the connective tissue. Yet a deep lumen lined by epithelium had once existed after ten months. In large cysts, the leveling of the cavity, reaching to the depression, takes months and years.

Therefore, contrary to the advice of dentists, the rhinologic method must be preferred with primary closure of the wound in the mouth, because the duration of healing is short and no after-treatment is necessary.

Large cysts of a dental root which have grown into the maxillary antrum should be operated on according to the Luc-Caldwell method, but the cyst wall situated on the floor of the maxillary antrum should not be touched.

If the maxillary antrum is not affected, cysts that have developed between the palate and the nose are operated on by saving the wall of the floor and of the sides of the cyst, which is utilized as a nasal recess. The oral wound is closed primarily.

SUPERFICIAL DISEASES OF THE CEREBELLUM. F. LEIRI, Ztschr. f. Hals-, Nasen- u. Ohrenh. **16**:113 (July 31) 1926.

Previously, Leiri stated that the cerebellum is an organ for the innervation of the antagonistic muscles, whereby motions are controlled as desired and positions of the body are stabilized. Later, Leiri advanced the idea that the innervation of the antagonists, the proper function of the cerebellum, emanates from the nuclei of the cerebellum, whereas the cortex of the cerebellum inhibits and directs the antagonistic reflex. Lewy has found, in a patient suffering from a cyst of the cerebellum, that the contraction of the antagonists in the extensor was missing. Rieger has pointed out that quick successive motions are performed by virtue of these automatic antagonistic contractions of the muscles. Leiri thinks that the adiadokokinesis in cerebellar diseases may be traced to the loss of these contractions.

When a patient with cerebellar diseases executes quick movements, either with the wrist or with the metacarpophalangeal joints and with extended fingers ("piano playing test"), it is observed that adiadokokinesis becomes plainer than when the ordinary "puppet test" of Baginski is used. Leiri has found this phenomenon in four patients with unilateral disease of the cerebellum. When he placed these patients at a table with the volar side of the hand on it, and asked them to beat quickly on the surface, he could observe, in three patients, that the fingers did not return automatically to the first position, as they did on the healthy side, but that they remained motionless on the table. It is not caused by a stronger innervation of the agonists which supersede the antagonists, but by an inhibition of that action of the antagonists which causes the "back kick." The cerebellar innervation in intentional movements inhibits or modifies these movements. Anatomic conditions explain from which parts of the cerebral cortex this inhibiting influence emanates. It is known that pathways lead from the frontal and the temporal lobe, especially to the contralateral cerebellar hemisphere. These corticocerebellar paths and the cerebellar hemispheres show their greatest development in monkeys, and especially in man, who can best carry out intentional movements. The corticocerebellar pathways reach the cortex of the cerebellum (Edinger). This is

the first cerebellar station of the inhibiting impulses passing from the cerebral cortex to the area of cerebellar innervation in voluntary movements. This means that the cerebellar cortex also exercises an inhibiting influence on the essential cerebellar functions, the innervation of the antagonists in muscular efforts. Leiri previously had the idea that probably an inhibiting influence emanates from the frontal lobe of the brain and that it travels to the cortex of the cerebellum and makes itself felt in the innervation of the antagonists originating in the nuclei of the cerebellum. Warner and Olmsted had shown an inhibiting influence of the frontal lobe of the brain in muscular activity. The opinion prevails that cortical cerebellar diseases generally are without symptoms (Marie and Foix, André-Thomas). Bárány thinks that in conditions that are confined to the cerebellar cortex only temporary spontaneous past pointing occurs as a symptom; yet the same phenomenon is found not infrequently in diseases of the frontal lobe of the brain.

Leiri reports two cases: The first patient, a woman, aged 40, who had suffered from a chronic middle ear suppuration for twenty-five years, was admitted to the ear clinic, Jan. 5, 1926. For two years the patient suffered from pain in the right ear. For two weeks shortly before Christmas the mouth was drawn to the right. A few days previously she had suffered from headache and dizziness. The patient said that the room turned from the left to the right. $V = \frac{0}{>6\text{ m.}} : v = \frac{0}{5\text{ m.}}$ The Weber test was not lateralized. On the right ear the Schwabach test was shortened, the lower tone limit was c^2, the upper f^6. There was no spontaneous nystagmus. When the patient was turned ten times to the right, a plain nystagmus to the left appeared, lasting fifteen seconds; when she was turned ten times to the left, a plain nystagmus to the right appeared, which lasted ten seconds. The right ear showed a plain caloric nystagmus with water of a temperature of 68 F. after from about five to ten seconds. Results of the Romberg test were negative. Mimic movements were symmetric. There was no choked disk. A radical mastoid operation was performed by Professor Af Forselles. Symptoms of intracranial pressure developed quickly, headache, a slow pulse and beginning choked disk. No hypermetric movements were noticed, but "marche a petits pas" and difficulty to execute quick flexion, "piano playing motions," with the fingers of the right hand. The most pronounced symptom was a premature inhibition in the finger-nose test, which was most pronounced in the right arm. Spontaneous past pointing was present in both arms. An abscess on the surface of the right cerebellar hemisphere was diagnosed and operated by Professor Af Forselles. The adiadokokinesis disappeared after the operation. The finger-nose test no longer showed inhibition. Therefore, it is probable that the inhibiting phenomenon was caused by a superficial focus in the right cerebellar hemisphere. The patient recovered.

The second patient, a man, aged 21, was admitted to the clinic, Feb. 5, 1926. The diagnosis was acute middle ear suppuration in the left ear, with lateral sinus thrombosis and cerebellar abscess on the left side, which were operated on by Dr. Gadolin on the same day. The patient recovered. This patient walked with short steps and showed a plain inhibition of motion when the finger-nose test was made. Increased intracranial pressure caused this test to be positive also on the side that was not affected. A plain adiadokokinesis was found on the left side by the "puppet" and "piano playing" tests. The abscess in the left cerebellar hemisphere reached 3 cm. forward and downward and 3 cm. inward. The patient recovered.

AMBERG, Detroit.

Society Transactions

CHICAGO LARYNGOLOGICAL AND OTOLOGICAL SOCIETY

October Meeting, Oct. 4, 1926

ARTHUR M. CORWIN, M.D., *President, in the Chair*

CANCER. Presented by DR. GEORGE W. BOOT.

Dr. Boot presented two white mice that had tar cancers and stated that the animals had developed papillomas before the appearance of the epitheliomas. Mrs. Boot had recently died from cancer of the stomach, and two or three years before there had been any signs of this disease, she had developed numerous papillomas on the backs of the hands and neck. With this fact in mind, and the fact that the mice had developed papillomas before they developed the epitheliomas, he thought of a possible connection. Two or three weeks previously, he had been consulted at the Cook County Hospital by a police sergeant who had cancer of the throat. He asked this patient whether he had had any warts and found that he had about a dozen on the palms which had been present for two or three years. In one other case of cancer in the hospital, the patient had one wart on the hand. In the wards he found a number of other cases, and about half of the patients had developed groups of small warts before they had had any symptoms of cancer. A private patient with cancer of the tongue said that groups of warts had developed every summer for three of four years. Dr. Boot felt certain that there is a relationship between the groups of small warts and the development of carcinoma, and expressed a desire to have the members of the Society keep this point in mind and make a record in every case.

DISCUSSION

DR. JOSEPH C. BECK: I published an article in *Laryngoscope* several years before, in which I reported on the work of Busbaum who injected toluylene red yeast into animals and produced carcinoma. There is no question but that cancerous tissue developed following the introduction of the red yeast into the animals. Hearing the statement that this was only an animal experiment and that mice and fowl easily develop cancerous tissue, a young Russian boy, who was assisting Dr. Beck in the laboratory, became so incensed at this attitude of doubt concerning the work of his master that without the knowledge of any one he injected some of the toluylene into his leg. Within five weeks, he developed a lump in the leg. They were greatly shocked that he had done this thing but the boy said, "What do I amount to if I can not disprove this statement regarding the work of my master?" A judge was consulted as to what had best be done, and he ruled that the lesion should be removed. This was done, and the boy never developed any later growth at the site of the lesion, although it was much like those in the animals. These cancers may be similar to the chimney sweep's cancer which produces an epithelial growth, or a paraffinoma, which contains carbon particles, which will stimulate epithelial growth and produce the lesions.

DR. BOOT: I have failed to produce any ulcers or papillomas in white rats, although I have treated them in the same way. I do not believe the growth referred to by Dr. Beck was a carcinoma, because it was encapsulated.

LARYNGEAL CARCINOMA. Presented by DR. AUSTIN A. HAYDEN.

Dr. Hayden presented a specimen of a laryngeal carcinoma which had been removed from a man who for eighteen months had had slight difficulty with his voice. He had been seen first by Dr. Hayden about Aug. 1, 1926, and for several weeks previously had been dyspneic. He had received deep roentgen-ray treatments externally, some of the treatments having been given by a chiropractor in Little Rock, Ark. When Dr. Hayden had first seen him, he had had a large extrinsic swelling over the larynx, which had been opened just through the skin. He was immediately sent to the hospital. The dyspnea became so acute shortly after his arrival there that an emergency tracheotomy was performed, with relief for about ten days. At the end of that time, Dr. Hayden had been called at about 2:00 a. m. by the intern and told that the man had had a hemorrhage and had died. The hemorrhage had started somewhere above the tube, and the man had been suffocated by his own blood before anything could be done.

The interesting feature of the case was the complete absence of metastases anywhere in the body, as proved by a complete necropsy made by Laurence H. Hines, pathologist at St. Joseph's Hospital. The man was apparently in perfect health with the exception of the laryngeal growth, which indicates that there are many things that are not yet known about the toxemias of malignancy. The patient had been seen by Dr. Theobald four months earlier, after which he had returned to the chiropractor in Little Rock.

LARYNGEAL CARCINOMA. Presented by DR. GEORGE W. BOOT.

A patient who had edema of the larynx was operated on by a general surgeon for goiter. Following the operation he did well for several days, then had acute jaundice and died from obstruction of the larynx. A specimen removed at necropsy showed marked edema of the larynx.

DISCUSSION
ON LARYNGEAL CARCINOMA

DR. WALTER H. THEOBALD: I saw the patient whose case was reported by Dr. Hayden on one occasion about three months earlier. The man was 38 years old and had complained of hoarseness of one year's duration. His temperature was 99 F., and he had some cough. Examination showed an involvement of the entire left side of the larynx. The posterior third of the vocal cord was ulcerated, and this condition extended below the vocal cord. There was a marked edema of the epiglottis, and the arytenoid on the left was not movable. The right vocal cord approximated the left beyond the midline. Because of the long duration of his trouble and the slight rise in temperature, Dr. Theobald suggested a general examination. This was carried out by two men who said the patient was tuberculous. Previous to this a diagnosis of syphilis had been made, and the man had received ten or twelve injections of neoarsphenamine, although at no time had the Wassermann reaction been positive. I saw the patient on one occasion after he had consulted Dr. Hayden and the tracheotomy had been performed. At that time he was comfortable and hopeful, and expected to have a complete laryngectomy performed. The next information I had was that the patient had died from the hemorrhage reported by Dr. Hayden.

DR. JOSEPH C. BECK: The great hope of the radiologists is that the use of radiotherapy will prevent metastases. I have seen many patients with metastases and all treated by radium and roentgen-ray have followed about the same course. I believe that the toxemia and cachexia in these cases are not due to the carcinoma

alone, but also to the radium and roentgen-ray toxemia which is produced by the constant absorption of the necrotic material that follows the massive death of tissue resulting from radiotherapy. These patients develop radiophobia, fear of the symptoms of radiotoxemia, from the absorption of the poisons following the death of the tissues. Not only the carcinoma but the normal tissues also are destroyed in the vicinity in which the radiotherapy acts.

DR. GEORGE F. FISKE: In this case in which there were no signs of metastases would a complete laryngectomy have given any chance of complete recovery?

DR. JOSEPH C. BECK: I think that if a suction apparatus had been immediately available, the man's life might have been saved.

DR. AUSTIN A. HAYDEN: I was waiting for the man's physical condition to improve before attempting a laryngectomy, and the hemorrhagic termination was unexpected. A complete laryngectomy would have been performed a little later.

As to the possibility of preventing such a death by means of suction, this can not always be done. An apparatus was at the bedside. The nurse and the man's wife were in the room with the patient, the wife sleeping, when the man coughed violently once or twice, expelling a quantity of blood from the tracheotomy tube. The suction machine was started at once, but in spite of this he died. Probably a considerable amount of blood trickled down into the trachea and lungs before the man awoke, for he had been sleeping, for an hour or so, up to the time the coughing started. He had received an opiate about three hours before, which may have lessened the tracheal sensitivity.

DR. HAYDEN then presented a piece of a pork bone which had been removed from the larynx of a patient who, while eating a roast pork sandwich, suddenly felt a sticking pain in the neck.

DR. GEORGE W. BOOT: There must be something more than absorption from dead tissue that causes the toxemia in patients treated by radiotherapy. Only a small number of growths are destroyed in this way, but the toxemia is present in all cases.

Referring to the foreign body exhibited by Dr. Hayden, I was recently called to see a patient who had been eating macaroni. The man had fallen several years before and had fractured the cervical vertebrae, and it had been impossible to get a laryngoscope in place either with or without an anesthetic. As he had awakened from the anesthetic, however, he had vomited and had expelled a piece of meat as large as the end of a thumb.

AUSCULTATION AND PERCUSSION IN THE DIAGNOSIS OF ACCESSORY NASAL SINUS DISEASE. Presented by DR. AUSTIN A. HAYDEN.

As sound travels better in a dense medium, a vibrating tuning fork held on the forehead (all other things being equal) should be heard longer (duration) and louder (intensity) through a sinus filled with fluid (blood, serum or pus) or solid material (bone and thickened tumor tissue) than through its normal air-containing fellow of the opposite side, just the same as the approach of a train of cars can be heard louder (intensity) and earlier (duration) through the rails than through the air; conversely, just as an alarm clock under a bell jar becomes fainter as the air is exhausted, theoretically a "vacuum" sinus should transmit sound even less readily than the normal sinus filled with air at atmospheric pressure.

Certain sources of error must be avoided: the tuning fork and stethoscope must be held with firm, even pressure, the former always in the exact sagittal plane of the head, and the latter equally and symmetrically over each antrum,

frontal or mastoid, as the case may be. With a little experience, differences in intensity can be readily detected. Throwing the lever back and forth quickly is essential for accurate comparisons, as the sound intensity of even a ninety second fork fades away with surprising rapidity. Duration of sound is difficult to determine. However, with a little experience an average of not less than three tests should reduce this source of error to about 10 per cent; consequently, only differences greater than this should be considered significant. If the observer's own hearing is defective, suitable allowances should be made. Extraneous noises should be excluded as far as possible, and the tuning fork struck as nearly as possible with equal force each time.

In the majority of the cases reported, diseased antrums and frontal sinuses auscultated louder and longer, as did sclerotic and acutely inflamed mastoids when compared with an opposite pneumatic normal side. The percussion impact of the observer's clenched fist on the top of the patient's head is felt distinctly in the acutely diseased sinus or tooth pulp. It would seem fair to state that auscultation and percussion may become procedures of value in the diagnosis of accessory nasal sinus disease. They are purely objective symptoms. The evidence that they can be expected to furnish will be only corroborative, but it will be worthy of consideration if the observations of others confirm what has been set forth here.

DISCUSSION

Dr. Albert H. Andrews: Some years ago, I was interested in the same specialty as Dr. Hayden and made some observations, especially on the mastoid. This was before the days of the roentgen ray and before transillumination was the rule. These things have made auscultation of the mastoid unnecessary, and offer a much better means of diagnosis.

Referring to the difficulties mentioned by Dr. Hayden, not having had any experience with the method, the difficulties I see are only theoretical. I believe that Dr. Hayden would experience difficulty in getting patients to place the two bells of the stethoscope in the same way, with the same amount of pressure, and I think that he should arrange some mechanical means of placing the bells and regulating the pressure.

In regard to the time during which the vibrations can be heard, there would be the same trouble as with the mastoid. If the fork is placed on the head and immediately held tightly against the head, the sound will be heard by bone conduction only two-thirds as long as if it is started and permitted to run for a time before being placed on the head. If the sound disappears for a moment, by making deeper pressure it will be heard again.

I wish to express my gratitude to Dr. Hayden for calling attention to this means of diagnosis. I shall immediately start making the examinations suggested by Dr. Hayden. I shall use ordinary soft rubber tubes until I can get the apparatus described and presented, compressing the tubes with my fingers.

In my work several years ago, I became interested one day in what was going on in the mastoid of a patient sitting before me in the clinic. I placed the bell of a small stethoscope on the tip of the mastoid and the handle of a tuning fork above it, and found that the sound on the diseased side was much louder than on the opposite side. After considerable experience with the test, I decided that it was a good means of determining whether the sinus was filled or empty. I was able also to determine by this means whether the lateral sinus was well back or forward. As soon as the tuning fork passed over the lateral sinus to the mastoid the sound became much louder. Another experiment which I made, but which

I do not think I originated, was that of placing the ordinary auscultation tube in the patient's ear, the operator listening to the tuning fork and then comparing it with the other side. In this way I found that the sound was much plainer on the affected side.

Dr. Robert Sonnenschein: No matter how honestly a man may perform research, or how earnestly he may search the literature, he may find, after publication, that the work has been done before. I was reminded of this about a year ago when I found an article of only ten or twelve lines by Bonnier of Paris, who in 1899 had presented before the International Congress an idea similar to the one I proposed of using the fork stem for both air and bone conduction. Some years ago, when the Canfield-Sturman operation was devised, both workers had published the method in different journals at about the same time.

I was surprised to find that the patient heard the sound only about the same length of time by air conduction as by bone conduction. I believe that he should have heard it longer. Bezold found that if he placed a tuning fork on the head of a person, by means of a stethoscope on the head the observer would hear the sound from ten to twelve seconds longer than the examined person. This was supposed to be a frank illustration of the fact that air conduction is better than bone conduction. In a thick wall tube the sound waves do not go through the wall of the tube but through the lumen, and the subject hears by air conduction.

I agree with Dr. Hayden that it is important to keep the tuning fork in the midline of the head. If it is even a little to the left, the sound will be heard more readily on the right side of the head and vice versa, and whether one is making the examination of the sinus or otherwise, care must be taken to keep the fork in the midline. The fork Dr. Hayden used sounded only thirty seconds, and it was necessary to switch from one side to the other quickly because the tone dies down so soon. I think that it would be well to use the Edelmann fork or some other good fork which will vibrate as a rule from 120 to 180 seconds, and can be heard by bone for ninety seconds. In this way, one would have no difficulty in having the sound continue long enough, even if the lever were not switched so rapidly from one side to the other.

Dr. Albert H. Andrews: I wish to call attention to the difference between originality and priority. Many persons do things that are original with them that may have been done hundreds or thousands of times before. Knowing nothing about this, the person thinks that he is doing original work. I believe that I am safe in saying that while I have done some original work I have never asserted priority in anything, for if one goes back far enough in the literature one will doubtless find that the same work has been done before.

Dr. George W. Boot: I wish to ask Dr. Hayden whether he has tried out the method on any patients with one frontal sinus absent; if so, what was the result?

Dr. J. Holinger: In one case, in the auscultation the pitch seemed to be changed. This was a frequent observation. While the loudness changed it seemed that the pitch had changed. The unaffected side sounded from half a tone to a full tone higher; I think that this should be borne in mind.

Referring to the closure of one side of the nose, I think that it is natural that the closed side should sound louder. It is not a question of more or less air going through, but a question of conduction of sound. A partially closed nose will conduct sound better, although not so much air will go through.

Dr. Elmer L. Kenyon: If a patient is nervous he might hold the lower jaw firmly against the upper, and in that way change the vibration. It would be wise to have the mouth held slightly open in making the test.

DR. HAYDEN: Replying to Dr. Sonnenschein, I think that it is considerably easier to tell the difference in loudness when the sound is fairly large than when the tuning fork is ceasing to vibrate. For this reason I believe that the rapidity with which the little lever can be moved back and forth in comparing the sounds is important.

I am grateful to both Dr. Sonnenschein and Dr. Holinger for the suggestion that a longer duration type of fork might improve the accuracy of the results. As to making the examination with the mouth open, as Dr. Kenyon suggested, I have not tried this but I have noted that an abscess tooth in the lower jaw does not respond as accurately to percussion in registering soreness as one in the upper jaw. The upper jaw being a continuous plate of bone, the vibration is transmitted easily. The lower jaw does not transmit so easily except when firmly fixed against the upper.

There have not been any cases available in which the frontal sinus was absent.

I regret that I have not known of Dr. Andrews' previous work. If I had had the advantage of his experience, I could have written a much better paper.

DR. ARTHUR M. CORWIN, DR. JOHN A. CAVANAUGH and DR. ROBERT SONNENSCHEIN addressed the members of the Society on "Otolaryngologic Items of Interest from Abroad."

A. H. HAYDEN, M.D., SEC.

COLLEGE OF PHYSICIANS OF PHILADELPHIA, SECTION ON OTOLOGY AND LARYNGOLOGY

Oct. 20, 1926

TYPHOID ULCERATION OF THE LARYNX. Presented by DR. JOHN R. DAVIS, JR.

In 1860 Barthey first called attention to the occurrence of laryngeal conditions in typhoid fever. Later observations were made and recorded by many other authors. Most observers consider the condition rather infrequent. In Munich, Fussell found that only fifteen of 2,000 cases showed laryngeal involvement. Other investigators reported similar infrequency. One notable exception was the series of cases reported by Jackson, who found laryngeal involvement in a much higher percentage of cases than any other observer.

A colored man, aged 24, developed a laryngeal lesion during the sixth week of typhoid fever. This subsided, but again became active in the ninth week when tracheotomy was required. Dyspnea was not relieved and death followed in twenty-seven hours. Necropsy revealed atelectasis of both lungs due to blockage of the bronchi with mucus. Extreme swelling of the vocal cords which entirely obliterated the glottic chink was found.

DISCUSSION

DR. J. A. BABBITT: In a case of laryngeal ulceration in which both arytenoid cartileges were coughed up, the patient retained a fair speaking voice.

DR. G. B. WOOD: In a child with typhoid fever, it was necessary to perform a tracheotomy.

DR. LOUIS CLERF referred to laryngeal stenosis in adults following typhoid laryngitis in childhood.

DR. C. B. EVES: In the laryngeal lesion of an adult who during typhoid fever required tracheotomy, no typhoid bacilli were found.

AURAL EXOSTOSES. Presented by DR. G. M. MARSHALL.

An adult, aged 66, became deaf on account of closure of the canal by a bony growth. Recovery followed surgical removal. Another man, suffering from pain and deafness, had an obstructive bony growth which when found was removed. The pain was relieved, but deafness persisted as the patient had worked for years in a boiler factory.

EXPOSED BONE FOLLOWING RADICAL MASTOID OPERATION. Presented by DR. G. M. MARSHALL.

A radical mastoid operation was performed two years ago on a woman. The interesting feature of this case was the condition of the bone of the anterior and posterior portions of the innermost extremity of the canal. The bone in this region was dark, had no epithelial covering and had the feeling of necrotic bone. On account of the absence of symptoms, no attempt at removal was advised.

DISCUSSION

DR. HUNTER: In about 2,000 aural examinations on service men I found a considerable number of exostoses, none of which required interference. Most of these are probably an unusually large tympanic spine at the notch of Rivinus.

DR. GEORGE FETTEROLF: Exostoses of the aural canal are of frequent occurrence in England. By some, this is considered the result of bathing in cold water.

DR. GEORGE COATES: I have seen many exostoses of varying size. So far, none has demanded surgical removal.

DR. W. B. DAVIS: In a case of long-standing suppurative otitis media, nature, by bony necrosis, performed a complete mastoid operation.

DR. G. M. MARSHALL: German observers found no exostoses of the aural canal in an examination of 1,900 children. These exostoses seem to have a predilection for the outer portion of the bony canal, and are probably the result of some irritative process. Examinations of the skulls of primitive races showed that the condition was common. It is especially common in swimmers and divers.

ORBITAL ABSCESS SECONDARY TO ETHMOIDAL INFECTION IN CHILDREN. A REPORT OF TWO CASES. Presented by DR. WARREN B. DAVIS.

The ophthalmic and rhinologic literature indicates that approximately 60 per cent of orbital abscesses are secondary to sinus infection; the majority of these are from the ethmoidal region and occur especially during childhood. Probably most of these abscesses are due to contiguity, but it is possible that in some cases phlebitis of ethmoidal veins or lymphatic infection may explain their occurrence.

A child, aged 12 years, presented typical local and general symptoms of orbital abscess with purulent discharge from the right middle meatus. On opening the anterior ethmoid cells, a large amount of pus escaped. Complete recovery followed.

A child, aged 5 years, developed a left orbital abscess secondary to ethmoid infection. This was completely relieved by operation on the ethmoid cells.

DISCUSSION

Dr. G. B. Wood: In two cases, orbital abscess was secondary to sinus suppuration. The abscess following ethmoiditis was relieved by operation. In the other, the abscess followed perforation of the inferior orbital plate during empyema of the antrum of Highmore.

Dr. F. O. Lewis: In an abscess of the orbit in a child, the condition was secondary to ethmoiditis. This was entirely relieved by external operation.

Nasopharyngeal Cyst. Presented by Dr. William Hewson.

In a woman, aged 24, on removing the tonsils under general anesthesia, a cyst about the size of an almond was found in the midline on the posterior wall of the nasopharynx. No adenoid tissue was present. On incision, thick pus escaped. The diagnosis of nasopharyngeal cyst or cold abscess was made. Thornwaldt's disease was considered, but the absence of pharyngeal tonsil made this diagnosis untenable.

DISCUSSION

Dr. George Fetterolf: The condition could possibly be due to incomplete closure of the duct which in embryonic life leads to the pituitary body.

Dr. W. B. Davis: Dissections show that a number of persons retain some remnant of this duct.

Dr. J. Clarence Keeler: I removed a similar cyst five years ago. Recurrence followed removal.

Book Review

CONTRIBUTIONS ON THE ART AND SCIENCE OF OTOLOGY LECTURES AND PAPERS. By RICHARD LAKE, F.R.C.S. Price, $5.00. Pp. 255. MacMillan & Company, Ltd., London, 1926.

This book is a compilation of addresses and discussions in the field of clinical otology extending over a period of thirty-three years, by a man actively engaged in practice. They are interesting as relating the perusals of one interested in the clinical problems of the specialty. There is nothing in this work that partakes of the character of research, and, as the author states in his preface, "certain of the views and treatments herein expressed have been modified."

One could write a whole volume pointing out palpable misconceptions regarding the views that have been established in this special field. What, for example, can the author mean, on page 67, when he states that "the Weber was positive on the right (normal side) while on the left (affected side) there was no bone conduction?" or, on page 177, when he states that a child was "entirely deaf on one side both to osseous and aerial conduction" while there was otherwise good hearing on the opposite side? A person who has suffered complete destruction of the hearing mechanism on one side hears the tuning fork exactly as long in most instances when it is placed on the mastoid of the affected side as he does when it is placed on the normal side.

The symptom of vertigo is discussed in a number of papers, but often there is a failure to make accurate observations, and the author does not seem to have grasped the real significance of this symptom. On page 142, speaking of vertigo from "suppuration within the labyrinth," the statement is made that "the tendency is for the sufferer to fall away from the affected side," and, on page 181, that the "great majority of vertiginous cases occur as a complication of chronic progressive middle ear deafness." His reports of operations carried out on the labyrinth for relief of vertigo and tinnitus in nonsuppurative cases are of interest, since the author stands practically alone in undertaking this heroic treatment.

In his discussion on otosclerosis, he is disturbed by the fact that every one of the functional hearing reactions which are found in otosclerosis also occur separately or in combination in other forms of disease of the ear. How could he expect otherwise, since the disturbances in hearing in most cases of otosclerosis are the result of fixation of the conducting mechanism at the footplate of the stapes, the kind of condition which causes defective hearing in all tubotympanic processes? He misses the point by failing to mention that it is possible to exclude all tubotympanic processes as a cause for the defect in hearing in most cases of otosclerosis since, as one should expect, most of these cases occur in patients who have not previously had a tubotympanic disease.